# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

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**SEPTEMBER, 1926.**

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## GENERAL PHYSICS.

**1970.** *The Variation with Temperature of the Density of Liquids.* **A. Predwoditelew.** (Zeits. f. Physik, 36. 7. pp. 557–562, 1926.)—An empirical formula has been given by Saslawsky and Schaposchnikow for the variation with temperature of the density of liquids [see Abstract 2384 (1924)]. The present paper derives this relationship from the van der Waals equation. A. A. D.

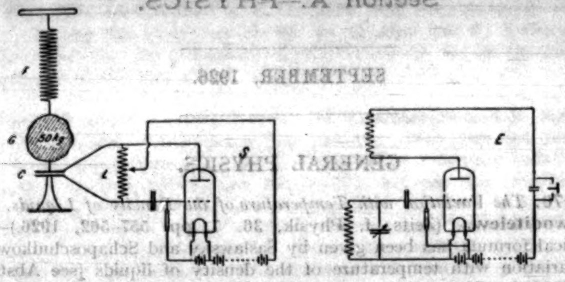
**1971.** *Density Determinations of Solids by a Modified Type of Gas Volume-Meter.* **G. M. Karns.** (Am. Chem. Soc., J. 48. pp. 1176–1178, May, 1926.)—A method devised for the determination of the densities of solids consists in the estimation of the volume of a weighed sample from the volume of air displaced. A given volume of air is displaced by mercury from a graduated bulb to a second enclosed bulb, and the pressure is measured by a mercury manometer. The solid to be measured is then mounted in the second bulb and the manometer reading again noted after the compression of the same volume of air. In the absence of possible errors due to vapour-pressure or adsorption, the density of samples of powders and crystals less than 0·2 c.c. in volume may be determined with an accuracy of 99·5 %. J. N. P.

**1972.** *Oscillating Watches.* **A. Jaquerod** and **H. Mügeli.** (Arch. des Sciences, 8. pp. 49–64, March–April, 1926.)—An experimental study of the forced vibrations of the balance-wheel of a watch freely suspended so as to be free to take up a pendular motion. A. D.

**1973.** *Volet's Differential Balance Wheel.* **H. Bock.** (Zeits. Instrumentenk. 46. pp. 138–143, March, 1926.)—In the balance wheel controlled by an elinvar spring there is usually some slight departure from exact correction. This arises from the fact that in practice it is impossible to produce elinvar always with exactly the same elastic properties. The error, however, is small and does not demand a return to the bimetallic balance wheels. In the present arrangement the solid rim of the balance wheel is made of brass and the single diametral spoke of invar. Attached to the rim of the wheel are two small balance weights always placed at the opposite ends of the same diameter. The angle between the diameter joining these weights and the single diametral spoke can be varied.

Clearly by means of this arrangement the moment of inertia of the wheel can be adjusted so as to bring about exact compensation. In this paper the problem is treated mathematically and a numerical example worked out. A. A. D.

**1974.** *Seismograph Vibration Indicator.* **P. Duckert.** (Zeits. Instrumentenk. 46. pp. 71–73, Feb., 1926.)—This paper describes an apparatus of the type indicated in the figure. Vibrations vary the separation of the plates of the condenser C and so affect the frequency of the oscillator S. The charge in frequency is observed by means of a second oscillator E arranged to interact with S on the heterodyne principle. W. H. G.



**1975.** *Instrument for the Survey of Mines.* **K. Lüdemann.** (Zeits. Instrumentenk. 46. pp. 148–150, March, 1926.)—Description of a combined telescope and compass needle for the rapid survey of mines or caves. A. A. D.

**1976.** *Sheet and Thread Manometers.* **E. Brüche.** (Ann. d. Physik, 79. 8. pp. 695–733, May 4, 1926.)—Discusses the theory of the thread manometers of Langmuir, Knudsen, and of Haber and Kirschbaum, in which the time taken for the amplitude of the vibrations of a hanging thread of quartz to diminish to half the original value is measured, and is used to determine the air-pressure in the bulb containing it. Shows the advantages that are to be gained by separating the damping surface from the portion of the apparatus which provides the elastic force of restitution; this cannot be done in the simple thread manometer. The author has devised a "surface" or "sheet" manometer, in which a rectangular sheet of very thin quartz is hung up by two corners from two threads of quartz and acts as a damper. The instrument described is suitable for pressures from 5/10,000 to 2/100 mm., and can be used outside these limits; it is provided with an arrangement for starting the vibration by means of an external magnet acting on a small piece of iron enclosed in quartz, so that the instrument can be used with corrosive gases and vapours. H. N. A.

**1977.** *New Types of Aircraft Instruments.* **F. L. Hunt.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 227–260, March, 1926.)—This paper summarises the work at the Bureau of Standards on the following aeronautic instruments: barometer and altimeters; a precision barograph;

statoscopes for indicating small changes of altitude; rotating cup anemometers; a ground speed indicator; a rate of climb indicator; compasses; an electric turn indicator; centrifugal and electrical tachometers; a ballonet volume indicator; an electric resistance thermometer; a fabric tension meter for the determination of the tension in the fabric of the outer covering of airships; an angle of incidence recorder; a kymograph, an instrument for the study of the oscillations of aeroplanes in flight; a water speedmeter for measuring the take-off and landing speeds of aeroplanes; and a dummy observer, a box containing the various indicators with a camera for periodically photographing the dials. A section on research problems is also included. E. G.

**1978.** *Aerodynamics of the Psychrometer.* **G. P. Paine.** (Harvard Coll. Obs., Annals, 87. Pt. 1. pp. 33–125, 1925.)

**1979.** *Measurements of the Surface-tension of Liquid Helium.* **A. T. van Urk, W. H. Keesom** and **H. K. Onnes.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 958–962, 1925. Comm. No. 179A from the Phys. Lab., Leiden.)—The determinations are carried out by a similar method to that employed [see Abstract 11 (1915)] in the case of hydrogen. A curve representing surface-tension as a function of temperature is obtained, from the straight portion of which the Eötvös constant is calculated, amounting to about 1·0. Helium thus conforms to the rule that normal substances in this respect form a series in which the Eötvös constant increases with the critical temperature. According to this rule the constant for helium must be the smallest, which is actually the case. A. B. C. L.

**1980.** *The Development of the Surface-tension in Newly Formed Surfaces of Solutions of Common Salt.* **E. Kleinmann.** (Ann. d. Physik, 80. 3. pp. 245–260, June 2, 1926.)—Employs the method used by F. Schmidt and H. Steyer with pure water [see Abstract 1497 (1926)], with a modification which makes it possible to work with the vertical microscope alone. When the curves for log of surface-tension and time are plotted they are found to be straight lines, showing that the surface-tension changes exponentially; the constant $\tau$, the time in which $\Delta a$, the difference between the instantaneous tension and the final statical value, falls to $1/e$ of its original value, is determined. Curves are given showing the changes in log $\delta a$, and the values of $\tau$, for different concentrations and temperatures. Kohlrausch's electrolytic degree of dissociation governs the dependence of $\tau$ on concentration, and the temperature coefficient of the ionic mobility governs its dependence on temperature. The connection between the phenomena and the formation of an electric double layer by movement of the electrons is discussed. H. N. A.

**1981.** *Determination of Surface-tension by the Method of Ripples.* **P. N. Ghosh, D. Banerji** and **S. K. Datta.** (Phil. Mag. 1. pp. 1252–1258, June, 1926.)—Describes a new stroboscopic arrangement, using a single electrically excited tuning-fork to excite the ripples and to work the stroboscopic arrangement. The results obtained are in fair agreement with those of Weinstein and Volkmann using the capillary tube method, but lower than those of other workers using different methods. The experiments were carried out with conductivity water at a number of different temperatures ranging from 18·5° C. to 64·1° C. H. N. A.

**1982.** *Surface-tension of Solids.* **G. N. Antonoff.** (Phil. Mag. 1. pp. 1258–1266, June, 1926.)—It is assumed that if the surface-tension of a liquid is greater than that of the solid forming a capillary tube, there is a capillary depression, if the reverse is true there is a rise, while there is neither rise nor fall when the two surface-tensions are equal. Experiments were made with a capillary tube coated inside with paraffin and solutions of isobutyric acid of different concentrations; a strong solution gave a rise in the tube and a weak one a fall, and it was possible to determine the strength of solution which gave neither rise nor fall and thus determine the surface-tension of the paraffin and also of beeswax. A mixture of lamp-black and salad oil behaves as though it had a definite surface-tension, depending on the proportions, and varying from 3·5 dynes per cm. upwards. When a glass tube is filled with the paste, which is then removed, the tube remains coated with the paste in some cases, while in others this is not so; this depends on whether the surface-tension of the paste is less or greater than that of the material of the tube. By finding the mixture which just does not stick a surface-tension of 130 dynes per cm. has been found for one kind of glass and of 315 dynes per cm. for rock-salt. H. N. A.

**1983.** *A Neglected Capillarity Effect.* **F. M. Denton.** (Science, 63. p. 339, March 26, 1926.)—The head of water supported by a water-gasoline chaplet of drops is independent of the length of the drops; between ten and thirty drops it is roughly proportional to the number of drops and inversely proportional to the diameter of the bore of the tube. A chaplet consisting of thirty drops of gasoline alternating with twenty-nine drops of water supports a head of about 15 cm. of water. G. A. S.

**1984.** *Effect of Temperature on the Viscosity of Air.* **A. O. Rankine.** (Roy. Soc., Proc. 111. pp. 219–223, May 1, 1926.)—The unexpected results arising from recent measurements of the viscosity of air from 15° C. to 1002° C. made by F. A. Williams [see Abstract 1193 (1926)] are discussed. The measurements recorded by Williams are compared with those obtained by Breitenbach and others, a discrepancy of 2·5 % to 3·5 % being noted in the former. Possible sources of error in Williams' determinations are considered to include inaccuracy of temperature measurement and calibration of the capillary tube employed. A. B. C. L.

**1985.** *Energetic Verification of d'Alembert's Paradox in Viscous Liquids.* **B. Finzi.** (Comptes Rendus, 182. pp. 1077–1079, May 3, 1926.)—A solid bounded by a surface $\sigma$ is moving with constant speed $c$ in a boundless viscous liquid, and if the speed $w$ of the fluid is zero at infinity, then line $P \longrightarrow \infty \; r^2 dw/dP = 0$ must be satisfied in the deduction of the classical paradox of d'Alembert for perfect liquids, where $r$ is the distance between a point $\theta$ and a point $P \longrightarrow \infty$. When the motion is permanent with respect to the solid, Cisotti has shown that the resultant force of the liquid on the solid is zero. The d'Alembert paradox continues therefore to exist when a viscous liquid is defined as a continuous medium whose equations of motion are those of Navier and Poisson. The author now shows, for the hypotheses specified, that the dissipation of energy in the liquid is zero. As a consequence, even from the energetic standpoint, the equations of Navier and Poisson do not characterise the motion of a natural viscous liquid. The paper is entirely mathematical. H. H. Ho.

**1986.** *Theory of Airscrews.* **S. Kawada.** (Tokyo Univ. Aeronaut. Research Inst. Report No. 14, pp. 361–404, March, 1926. In English.)

**1987.** *Aeroplane with Revolving Vanes.* **R. Moineau.** (Comptes Rendus, 182. pp. 1079–1082, May 3, 1926.)—Like the helicopter, this mechanism, devised by Moineau, seeks to attain vertical ascent and descent by means of one or several paddles whose axes can be adjusted according to the trajectory, control being attained by the oblique forces on the paddles. Mechanical details are included in this paper and two types of machine are described with data and criticism. H. H. Ho.

**1988.** *Wave Resistance.* **H. Lamb.** (Roy. Soc., Proc. 111. pp. 14–25, May 1, 1926.)—The case now mathematically considered is that of a solid, whose dimensions are small compared with its depth below the free surface, travelling horizontally under water. The particular case of a circular cylinder advancing at right angles to its length has been solved previously from considerations of group-velocity, and the more difficult problem of the sphere was worked out by Havelock [see Abstract 1338 (1917)] from the direct calculation of the pressures exerted on its surface, a method he modified later by a calculation of the travelling pressures applied to the free surface which would produce the same wave system. The present investigation is on a more general plan, no restriction being made as to the form of the solid, since this affects only the values of certain constants. Also it is unnecessary even to assume that the solid is moving in one of the directions of free permanent translation of which it is capable, and some attention is paid to cases where this condition is departed from. As a further variation from previous methods a small viscous force is introduced, and the work done against resistance is equated to the dissipation of energy. H. H. Ho.

**1989.** *The Resistance Law of Quickly Moving Spheres in Water.* **W. Bauer.** (Ann. d. Physik, 80. 3. pp. 232–244, June 2, 1926.)—This paper contains comprehensive experimental details for the measurement of the velocities of spheres travelling rapidly through water, together with an adequate description of the precautions for the removal of sources of error. The velocities measured ranged from 650–150 m./sec., and conformed to a purely quadratic resistance-law, $W = \psi\rho F v^2$, in which the resistance factor $\psi$ had the constant value 0·15. There also entered a penetration resistance of the projectile in the water mass which for all observed velocities entailed a loss of 2·6 %. A comparison with the $\psi$ values which Prandtl found for spheres in air at Reynold numbers up to 370,000, showed it probable that the $\psi$ values now determined for Reynold numbers of 1,400,000–6,000,000 might be regarded as fitting a continuation of the Prandtl $\psi$-curve. H. H. Ho.

**1990.** *Variation of Logarithmic Decrement in Metals.* **G. Subrahmaniam.** (Phil. Mag. 1. pp. 1074–1081, May, 1926.)—The decrement-amplitude curves for tungsten, silver, platinoid and phosphor-bronze wires run parallel to the $x$-axis until a limiting twist is reached, and thereafter increase more or less linearly with the amplitude. Curves for platinum, nickel and gold rise proportionately with the amplitude.

With regard to lead and tin wires no detailed investigation was practicable. The twist given was about 5°, except in the case of gold, lead and tin, when it was much smaller. W. A. R.

**1991.** *Effect of Axial Restraint on the Stress in a Rotating Disc.* **W. G. Green.** (Phil. Mag. 1. pp. 1236–1251, June, 1926.)—When a rotating disc is carried on a shaft one effect of the shaft is to prevent the parts of the disc near the axis from shifting as far in the direction of the axis as they would otherwise. Two stress systems are produced, (A) that due to concentrated axial tensions P in a complete disc at rest and (B) that due to rotation in a complete disc under no superficial tractions. For (A) the radius has to be considered infinite, but the error due to this is small; for (B) Chree's solution is taken. The stresses arising from a concentrated force acting at a point on the plane boundary of an elastic solid are dealt with, and by means of the results obtained the stress-system due to concentrated axial tensions P in a complete disc at rest are developed, tables and curves being given. The stress system (B) due to rotation only is dealt with, the axial tensions and the total stress-components when rotating under restraint are determined, and the effect of the radius of the shaft is considered. H. N. A.

**1992.** *On Forced Frictional Oscillations.* **W. Eckolt.** (Zeits. techn. Physik, 7. 5. pp. 226–232, 1926.)—In this entirely mathematical paper an investigation is made of forced oscillations under frictional conditions. The introduction of friction as a Coulomb resistance prevents a complete analytical treatment of the subject, but by means of tables and graphs, included in the paper, relationships are deduced to a sufficient degree of approximation. A comparison is made between unimpeded and damped forced oscillations. H. H. Ho.

**1993.** *Elastic Stability of a Corrugated Plate.* **W. R. Dean.** (Roy. Soc., Proc. 111. pp. 144–167, May 1, 1926.)—This paper deals with the elastic stability of a corrugated plate under thrust along its generators. Besides the assumption, common to all such problems, that the plate is thin, it is supposed that the depth $d$ of a bay is a small multiple of the semi-thickness $h$, and that the transverse expansion—that is, the usual accompaniment of a longitudinal thrust—is prevented by a thrust in a perpendicular direction. The equations derived are then soluble, and the critical stress in any case can be found from an equation expressing that an infinite determinant is zero. The numerical work has been limited to the cases, $d = 10h$ and $d = 5h$ respectively, and as a preliminary Poisson's ratio $\sigma$ has been assumed as zero. From the simplified equations the favourite types of distortion have been found and are then shown to be the same when $\sigma$ is not zero. Numerical results are given for $\sigma = 1/4$. The possible application of this work is to the use in aeroplane construction of corrugated plates which must be light and yet take considerable loads. The paper is mathematical throughout, its extension to plates with deeper bays is considered, and the general nature of the favourite types of distortion stated. H. H. Ho.

**1994.** *Moduli of Elasticity and Rigidity, and their Change caused by Magnetisation in Different Kinds of Steel.* **K. Honda** and **T. Tanaka.** (Tôhoku Univ., Sci. Reports, 15. pp. 1–37, April, 1926. In English.

Report No. 116 of the Research Inst. for Iron, Steel and other Metals.)—In the case of the carbon steels, the moduli of elasticity and rigidity were determined both in the annealed and quenched states. Both moduli decrease steadily with increasing carbon, and both are also decreased by quenching. Magnetisation increases both constants. In the case of the cobalt-iron alloys the elastic constants are increased by magnetisation except in weak fields in the case of alloys containing between 35–55 % of cobalt, in which a small decrease is observable. A similar decrease is also observable in the case of pure cobalt. With nickel steels the elastic constants are increased by magnetisation for all fields with the exception of the irreversible nickel steels, in which a small decrease of these constants occurs. Generally speaking, the effect of magnetisation on the moduli of rigidity is about three times as large as it is on the modulus of elasticity. The paper contains a number of tables and diagrams showing the numerical results in great detail. **A. A. D.**

**1995.** *Change of Speed of a Belt in the Vicinity of its Contact with the Pulley.* **R. Swyngedauw.** (Comptes Rendus, 182. pp. 959–962, April 19, 1926.)—The author describes the results of further experiments [see Abstract 1216 (1926)] by a different method. They confirm the results of the stroboscopic measurements. **G. W. de T.**

**1996.** *Modern Physical Bases of Chemical Theory.* **T. M. Lowry.** (Nature, 117. pp. 33–40, May 29, 1926. Supplement.)—The definite structure which has been shown to apply to atoms and molecules has been investigated by three different lines of work. Information on the volume of molecules has been derived from gas viscosity measurements, the spreading of thin films on liquid surfaces has given further information on their shape, while X-ray analysis of crystals has shown both the shape of the volume occupied by atoms and their modes of combination with each other. By the combination of Moseley's method of counting the number of electrons in the atom with the knowledge of the different possible orientation modes of chemical combination given by X-ray analysis and by the optical verification of Werner's coordination theory, it has become evident that two chief types of valency occur. In the polar type an electron or electrons are transferred from one ion to another. Thus among the polar type of compounds it is the ions that must be considered the stable form. Polar compounds simply represent aggregates of ions which are electrically neutral. Polar bonds are capable of any orientation, and thus crystals of polar compounds tend to possess close packed forms and to have a high density. Covalence on the other hand is due to the sharing by atoms of certain electrons whereby the outer shell of electrons associated with the two or more atoms tends to assume certain stable forms. The sharing of electrons is apparently in multiples of two, thus bringing the tetrahedral theory of carbon and the Bayer strain theory into line with the octet theory. On this theory covalence is a more definite, indivisible and oriented property than electrovalence, and in consonance with this crystals dependent on covalence are usually far from closely packed and have a low density. From the nature of these valencies it seems likely that residual affinity must be electrovalent. There is a further possibility when double bonds are considered. These may be either polar, non-polar or mixed. The existence of mixed double bonds has been shown by work on molecular volumes and, recently, by the optical activity of a sulphinate due to the presence of an unsymmetrical double bond. A. Wh.

**1997.** *Valence of Nitrogen and Hydrogen.* **A. A. Blanchard.** (Am. Chem. Soc., J. 48. pp. 1195–1198, May, 1926.)—Except in simple binary compounds, valency may be defined precisely in terms only of postulates regarding the arrangements of electrons. Whatever may be the function of the electrons in the atom, it is clearly indicated that they can occupy only certain definite and widely separated levels, and that the maximum numbers of electrons at the succeeding levels are 2, 8, 18, 32, etc. The average or static positions of electrons held in common are governed by Coulomb's law of electrostatic attraction and repulsion, subject to the requirements of the energy levels. Nitrogen can have but eight and hydrogen but two electrons in its valency shell, but phosphorus may have more than eight. If the non-polar valency is defined as the number of pairs held in common with other atoms, nitrogen may have a maximum non-polar valency of four; the polar valency may be regarded as plus five if it is defined as the net charge of the nitrogen kernel, or as minus three if it is defined as the charge of the nitrogen atom and the eight electrons of the sheath are regarded as part of the atom. The hydrogen bond is believed to consist of a hydrogen atom holding in its valency layer one electron of the valency layer of each of the two atoms thus bound together. T. H. P.

**1998.** *Molecular Weight Determinations by Centrifuging.* **T. Svedberg.** (Zeits. phys. Chem. 121. pp. 65–77, May 24, 1926.)—A further account is given of experiments on the determination of molecular weights from measurements of sedimentation equilibrium in solutions exposed to a centrifugal force. A description is given of the apparatus and the thermodynamical derivation of the values. Results with egg albumin show this to consist of a mixture of two compounds of molecular weights, 32,500 and 53,400. [See also Abstract 1674 (1926).] J. N. P.

**1999.** *Lattice Constants of the Platinum Metals, Silver and Gold.* **T. Barth and G. Lunde.** (Zeits. phys. Chem. 121. pp. 78–102, May 24, 1926.)—A determination is made of the lattice constants of the platinum metals, silver and gold, from measurements of the reflection angles for CuKβ-radiation. The influence of temperature and pressure on these constants is investigated. The following values are found: Silver, $a_0 = 4{\cdot}078$ Å.; gold, $a_0 = 4{\cdot}070$ Å.; iridium, $a_0 = 3{\cdot}823$ Å.; ruthenium (hexagonal), $a_0 = 2{\cdot}695$ Å., $c_0 = 4{\cdot}273$ Å.; osmium, $a_0 = 2{\cdot}724$ Å., $c_0 = 4{\cdot}314$ Å. On passing to the higher homologue the percentage increase of the lattice constants of ruthenium, rhodium, palladium and silver decreases with increasing pressure and increases with increasing temperature. The increase of lattice dimensions of homologues becomes smaller with increasing atomic number. The constants for the platinum metals, silver and gold at different temperatures and pressures, are calculated from heat expansion coefficients and compressibility. Analogous relations in regard to the effect of temperature and pressure are shown with the pairs of homologues, ruthenium-osmium and silver-gold, similarly to the property previously found with the lanthanum series. The relation of atomic and molecular volume of homologous elements, particularly with zirconium-hafnium and silver-gold, is discussed. From the new measurements of lattice constants a calculation is made of the atomic volumes of the elements of the eighth group. J. N. P.

**2000.** *Results of Crystal Analysis.* **L. Vegard.** (Phil. Mag. 1. pp. 1151–1193, May, 1926.)—The structures of zircon ($ZrSiO_4$), rutile $(TiO_2)_2$, cassiterite ($SnO_2$) and anatase ($TiO_2$) have been determined by Bragg's method [see Abstract 504 (1917)]. These results are now verified by the application of the method of Debye and Scherrer. Particulars are given of the lattice arrangements of the molecules in the above-mentioned substances, their space groups, dimensions of the elementary lattice, parameters and radii of the ions. Data are also given of analyses of crystals belonging to the scheelite group. G. E. A.

**2001.** *The Paramorphic Transformation Temperature of Cristobalite.* **R. Weil.** (Comptes Rendus, 182. pp. 1165–1167, May 10, 1926.)—Describes the experimental methods required to show that at different points of the same crystal the transformation, which is a sudden one, takes place at temperatures which are constant for a given region, but varies from one region to another. The temperature has to be altered very slowly to show this, from 8° to 16° C. per hour. The extreme limits observed for the transformation with artificial cristobalite are from 170° to 265°. The author considers that these differences are due to some impurity in the specimens. H. N. A.

**2002.** *The Ionic Charges in Chemical Compounds with Tetrahedral Crystal Structure.* **K. F. Niessen.** (Phys. Zeits. 27. pp. 299–306, May 15, 1926.)—In the theory proposed by H. Grimm and A. Sommerfeld, which assumes shells of four electrons instead of shells of eight electrons, it is supposed that when two atoms combine both elements first lose electrons until the configuration of the next lower inert gas is attained, and are then bound together as carbon atoms are bound in the diamond by means of the valence electrons. Thus when an atom from the first row of the periodic table combines with one from the seventh the atomic residues are both positive, and can be represented by $I^{+}$ and $VII^{+++++++}$, eight electrons being set free. These are assumed to circulate in pairs in elliptical orbits about neighbouring pairs of atoms, which are situated at the foci of the orbits, and the object of the present paper is to investigate the effect of the greater velocity of the electrons about the atomic residue with the larger charge; if the effective charge on the "ion" depends on how long the electrons are in its neighbourhood the negative charge of ion I and the positive charge of ion VII will be increased by this action, and the author shows that the X-ray scattering observed in certain crystals with diamond-like structure confirms the theory qualitatively. H. N. A.

**2003.** *A Simple Model for Illustrating the Atomic Arrangements in Crystals.* **R. W. G. Wyckoff** and **C. J. Ksanda.** (Am. J. Sci. 11. pp. 377–380, May, 1926.)—A simple model is described for showing the arrangement of the atoms in crystals. It consists essentially of a set of four long screws mounted on an appropriate base. A series of glass plates is supported by nuts moving on these screws. The atomic positions are shown by paper circles shellaced to the plates. This type of model has the advantages that it is easy to construct accurately, it is readily portable, it is applicable to the most complex structures, and it shows clearly the prevailing atomic relationships without interference from rods, wires, or other constructional details. J. E.

**2004.** *The Dynamic Model of the Chemical Bond and its Application to the Structure of Benzene.* **L. Pauling.** (Am. Chem. Soc., J. 48. pp. 1132–1143, May, 1926.)—Makes use of the hypothesis of Knorr that the shared electron valence bond is due to the rotation of a pair of electrons in orbits about the nuclei of the two atoms. The following electronic structure is proposed for the benzene molecule; the six carbon atoms and six hydrogen atoms are at the corners of two concentric, coplanar, regular hexagons with the hydrogen on the larger hexagon; each C atom is connected by two shared bonds of the above type with the two neighbouring C atoms, by a third such bond with the H atom outside it and by a fourth with the carbon atom directly opposite it in the hexagon; this bond consists of two electrons rotating in a longer orbit than the others. The six crossed orbits may be expected to form a stable arrangement, producing the stability of the benzene ring. The properties of benzene, naphthalene and anthracene, and in particular the size of their molecules, are discussed with reference to the proposed structures. H. N. A.

**2005.** *Atomic Numbers and the Properties of Ions in a Crystal.* **A. F. Scott.** (J. Phys. Chem. 30. pp. 577–594, May, 1926.)—On the same lines as an earlier paper [Abstract 1551 (1925)]. The characteristic frequencies of the elements and of some compounds are tabulated with a full discussion of the assumptions made in the cases where the physical data are insufficient. In the case of the elements the calculation is made with a modification of Lindemann's expression using the "nearest approach" of ions as determined by analysis of crystal structure. For the compounds an expression due to Madelung and Einstein is used when compressibility data are available. Assuming that the characteristic frequency $\nu$, Z the atomic number and $e$ valence electron, then $\nu = f(Z, e)$. Let this apply to the inert gases, then the next group of elements, the alkali metals, will be covered by a similar expression if the electronic structures are similar, but Z will be increased in each case by unity. Assuming the simplest case, this will result in the increase of $\nu$ by a constant parameter $\alpha$. Elements of succeeding groups will be affected by parameters $\beta$, $\nu$, 8. Without defining the form of the function, it is shown that the frequencies of the alkali metals are expressible as a linear function of the frequencies of the inert gases, the slope of the curve being $\alpha$. Similar relations hold for the alkali halides. It is also concluded that the constraint, defined as the restoring force on an ion per unit displacement, should be given by a relation of the form $k^{\frac{1}{2}} = a \log (Z_e - Z_a) + b$, and a diagram is given illustrating this for the elements and another for salts. A. Wh.

**2006.** *Attempts to Fractionate Mixed Isotopes of Lead, and the Atomic Weight of this Metal.* **T. W. Richards, H. S. King** and **L. P. Hall.** (Am. Chem. Soc., J. 48. pp. 1530–1543, June, 1926.)—Two methods were employed, that of irreversible evaporation *in vacuo* and fractionation by the Grignard method with phenyl-magnesium bromide. The first method was also used with a known mixture of uranium lead and ordinary lead.

The separation obtained was not in any case greater than the probable experimental error, which was very small. Eighteen different determinations of the atomic weight of lead were made in the course of the investigation, and taken together give the value 207·217 with a probable error of less than 0·001. It seems unlikely that isotopes can be separated by chemical treatment. H. N. A.

**2007.** *Spinning Electrons.* **A. S. Eddington, O. W. Richardson, F. A. Lindemann and J. Frenkel.** (Nature, 117. pp. 652–654, May 8, 1926.)

**A. S. Eddington:** On the theory of the spinning electron the periphery is supposed to move faster than light. The relativity theory raises no objection to this conception since the mass and energy of the electron lie in the steady fields and are not in themselves subject to this velocity. What really seems to be implied in this conception is that the charge-and-current vector, $J^\mu$, is space-like in contradistinction to macroscopic phenomena where $J^\mu$ is time-like. This is in accord with the previous conclusion deduced by this author from Weyl's action principle.

**O. W. Richardson:** Two objections raised by Kronig to the theory that electrons in an atom have inherent magnetic moments are examined and can be answered. If an electron in a Bohr orbit has a quantised spin it is likely that an electron forming part of a nucleus will have similar magnetic moment associated with it. It is suggested, however, that it is not likely to retain this individually, but will probably pass it on to the nucleus as a whole. The nucleus is known to possess a quantised magnetic moment on account of the gyromagnetic anomaly, and since the dimensions of the nucleus are not much greater than those of the electron, the probability of ordered spinning of the constituent electrons seems remote.

**F. A. Lindemann:** The stability of the nucleus is readily explained in terms of the rotation of electrons and protons. It has always been a problem how a nucleus could avoid complete disruption in virtue of its excess positive charge. If, however, the velocities of rotation are high, electrons and protons will be accompanied by magnetic fields which at these short distances will be capable of balancing the disruptive electrostatic forces.

**J. Frenkel:** Uhlenbeck and Goudsmit have shown that the quantised spinning electron can be used to explain the multiplet structure of spectrum lines and the anomalous Zeeman-effect. In the first case it is necessary to identify the ratio of the magnetic to the mechanical moment with the corresponding orbital ratio, and in the second case to double this quantity. This paper gives a *résumé* of a mathematical solution of the problem according to the special relativity theory which is to be published in full elsewhere. A. Wh.

**2008.** *Nuclear Structure.* **S. Ono.** (Phys. Math. Soc. Japan, Proc. 8. pp. 76–97, April, 1926. In English.)—The fundamental assumption is made that in general the protons in an atomic nucleus lie in two zones, an inner one solid and spherical and in which each proton is accompanied by a single electron, and an outer spherical shell in which the protons form pairs, each pair with one electron. If the atomic mass be M, atomic number N, number of protons in the inner part $n$, the distance between the layers $l$, $l_a$ the distance between the proton pairs on the outer shell, and $l_i$ the corresponding distance in the inner region, then it is shown that

$M = n + 2N = 1/6\sqrt{\pi}\,.\,(l_a/l_i)^3\,.\,(N^{\frac{1}{3}} - \sqrt{\pi}(l/l_a))^3 + 2N$. This formula expresses the facts accurately except in the case of light elements which are given a special treatment. The range of isotopes and the mechanism of radio-active transformations are also dealt with and are in satisfactory agreement with observations. A. Wh.

**2009.** *Number of Electrons and α-Particles in Atomic Nuclei.* **H. Nagaoka.** (Imp. Acad. Tokyo, Proc. 2. pp. 112–115, March, 1926. In English.)—Gives a table of the isotypes of fifty-six elements, the isotopic constitution of which has been studied by Aston, with the number of α-particles which are assumed to exist in the nucleus, and the surplus, *b*, of intra-nuclear electrons, not counting those included in the α-particles, over the circumnuclear ones. It is possible to choose the number of α-particles so that this surplus is either zero, or one for each of the known isotopes. With argon, for example, the atomic number, or the number of circumnuclear electrons, is 18; the total numbers of electrons, *a*, in the nuclei of the two isotopes 22 and 18. The first isotope is assumed to have two α-particles in its nucleus, and they contain four electrons, so that there are eighteen electrons outside the α-particles and protons of the nucleus, and *b* is zero. For the other isotope no α-particles are assumed; there are 18 electrons between the protons composing the nucleus, and *b* is again zero. For the three isotopes of magnesium, $a = 12, 13, 14$, the assumed numbers of α-particles are 0, 0, 1; the intra-nuclear "free" electrons 12, 13, 12; the circumnuclear electrons (atomic number) 12, and the surpluses $b = 0, 1, 0$. The author considers that there is a relation between these surpluses and the periodic arrangement of the elements. H. N. A.

**2010.** *Some Critical Remarks on Stintzing's proposed Structure of Atomic Nuclei.* **R. Reinicke.** (Zeits. f. Physik, 37. 3. pp. 210–216, 1926.)—Proposes certain modifications in the models shown in Stintzing's paper [see Abstract 466 (1926)]. The author seems inclined to think that the electrons outside the nucleus are built up in tetrahedra and do not revolve in elliptical orbits as supposed by Bohr. H. N. A.

**2011.** *The Magnetic Moment of the Electron.* **R. de L. Kronig.** (Nat. Acad. Sci., Proc. 12. pp. 328–330, May, 1926.)—Recent work on the analysis and classification of complicated spectra shows that their interpretation can best be given by assigning to every electron two moments of momentum characterised by quantum numbers K and R, using Landé's notation. The first is no doubt the quantum analogue of the orbital moment of momentum of the electron. Uhlenbeck and Goudsmit have suggested that R might be regarded as the moment of momentum of the electron itself, and furthermore that if the orientation of R with respect to the orbital plane is quantised, then the electron would have energies in these orientations whose difference obeys a relativistic doublet formula, going with the fourth power of the nuclear charge. The present paper calls attention to some difficulties which this hypothesis encounters. For example, to account for the Zeeman-effect the electron must be assumed to have a magnetic moment of two Bohr magnetons, about $10^{-20}$ c.g.s. units, and this would involve exceedingly high velocities of spin. T. B.

**2012.** *Time of Stay of Alkali Metals, Oxygen and Nitrogen.* **H. Kerschbaum.** (Ann. d. Physik, 79. 5. pp. 465–488, March 24, 1926.)—

Intense canal-rays of the alkali metals were produced in a special tube; the Doppler-shift gave a measure of ten velocities of the atoms; the absorption-coefficients were measured, and the mean time-of-stay and the damping estimated by Wein's method. The new values found are for $T \times 10^8$: H, 1·81; Li, 6·51; $N^+$, 1·35; N, 9·45; $O^+$, 1·53; O, 14·9; Na, 3·7. A. C. M.

**2013.** *The Interpretation of Certain Phenomena in Molecular Spectra.* **F. Hund.** (Zeits. f. Physik, 36. 9–10. pp. 657–674, 1926.)—The quantum models used in the explanation of atomic spectra are modified and suitably extended to molecular spectra, the relationship between the atomic and molecular spectra in the case of equal numbers of external electrons being discussed. Various empirically known phenomena remain unexplained. The paper is unsuitable for detailed abstraction. W. V. M.

**2014.** *Distribution of Intensity in Spectra, and Cascade Springs in Bohr's Atomic Model.* **H. Bartels.** (Zeits. f. Physik, 37. 1–2. pp. 35–59, 1926.)—The author attempts to discover how far the fact that an excited atom may return to the resting state by steps accounts for the connection between the distribution of the excitation over the various terms and the distribution of intensity in the spectrum. A method of treatment is developed which enables a clear view to be obtained of the complicated relations, and in particular examines the way in which the intensity falls off in a series, and the relation between the intensities in two different series, in order to find out their meaning. The discussion leads to different possibilities of explaining the distribution of the probabilities of the passages from one state to another, and of the excitation functions, with reference to measurements of intensity. The available experimental data are insufficient to make it possible to decide between them. H. N. A.

**2015.** *Small Free Oscillations of an Infinite Crystal Lattice.* **A. Wintner.** (Zeits. f. Physik, 37. 3. pp. 225–229, 1926.)—A mathematical note extending the treatment of a previous paper [see Abstract 1758 (1926)], with the application in view to infinite lattice theory. W. S. S.

**2016.** *Theory of the Fine Structure of Spectral Lines.* **M. Bronstein.** (Zeits. f. Physik, 37. 3. pp. 217–224, 1926.)—The author extends the theory of the motion of an electron in the field of a positive charge, given in an earlier paper [see Abstract 1252 (1926)], to the true two-body case. For this it is necessary to introduce some further hypothesis which shall determine the distribution of the mass of the system between the positive nucleus and the electron. It is postulated that the ratio of the rest-masses of these shall be independent of their distance apart. Quantum conditions are introduced as before, and an approximate solution of the problem obtained. It is found that now Sommerfeld's theory of fine structure is substantiated except for a small correction. The doublet separation is given by $\Delta\nu_H = \frac{R_H\alpha^2}{16}\left(1 - \frac{2m_e}{m_0}\right)$ instead of Sommerfeld's result $\Delta\nu_H = \frac{R_H\alpha^2}{16}$. Here $m_e$ and $m_0$ are the rest-masses of the electron and hydrogen nucleus when separated by an infinite distance. As the factor $\left(1-\frac{2m_0}{m_0'}\right)$ amounts to 0·999, the difference between the two results would not be detectable with present spectroscopic technique.

W. S. S.

**2017.** *Quantisation as a Problem of Characteristic Values. Part II.* **E. Schrödinger.** (Ann. d. Physik, 79. 6. 489–527, April 6, 1926.)—The author gives an extended discussion of the significance of the procedure employed in the previous communication [see Abstract 1512 (1926)]. The analogy between mechanics and optics drawn by Hamilton is developed in detail and the suggestion made that just as geometrical optics break down in diffraction phenomena and give place to wave theory, so "geometrical mechanics" (classical laws) which hold for matter in bulk are superseded at atomic dimensions by "undulatory mechanics" (quantum laws). This idea is worked out mathematically, and it is shown that a quantity arises which exhibits the properties of Planck's constant $h$. The latter half of the paper is given to applications of the method of Part I to the Planck oscillator, the rigid oscillator with fixed or free axis, and the vibrational rotator (diatomic molecule). W. S. S.

**2018.** *A Theorem on Space Quantisation.* **R. de L. Kronig.** (Nat. Acad. Sci., Proc. 12. pp. 330–334, May, 1926.)—If $a_0$ and $a_1$ represent the quantised angular momenta, say, of two electrons, measured in units $h/2\pi$, $a_0$ and $a_1$ being positive integers or half-integers, then the resultant $r_1$ may not have all the values between the extremes $|a_0 - a_1|$ and $a_0 + a_1$, but only a number of discrete values, differing successively by unity and found from the relation $|a_0 - a_1| \leq r_1 \leq a_0 + a_1$. If more momenta $a_2 \ldots a_m$ be added to the system such that the mutual energy of orientation of any of these with respect to the preceding ones is much smaller than that among these preceding ones, a proof is given of the theorem, "If a number of positive integers or half-integers $a_0, a_1 \ldots a_m$ are 'added' successively (in a manner indicated in the text) the final result is independent of the order in which they are added." An application of the theorem to complicated spectra is given. T. B.

**2019.** *Elimination of the Nodes in Quantum Mechanics.* **P. A. M. Dirac.** (Roy. Soc., Proc. 111. pp. 281–305, May 1, 1926.)—In classical treatments of the problem of a number of particles moving in a central field of force, an immediate simplification is transformation to a set of canonical variables such that these only determine the orientation of the whole system. In the absence of an external field of force, the Hamiltonian is independent of these and the equations of motion are much simplified. Using the quantum mechanics outlined previously [Abstract 1245 (1926)], an analogous transformation may be made, and in this paper, which is entirely mathematical, the method is developed. A. Wh.

**2020.** *Canonical Transformations in Quantum Mechanics.* **P. Jordan.** (Zeits. f. Physik, 37. 4–5. pp. 383–386, 1926.)—In this mathematical paper a proof is given of the previous assumption by Born, Heisenberg and Jordan [see Abstract 1229 (1926)] that the most general canonical transformations can be expressed in the form $P_k = Sp_kS^{-1}$, $Q_k = Sq_kS^{-1}$. It is also shown that the classical formulæ remain unaltered for point transformations. H. H. Ho.

**2021.** *Rotation Vibration Bands given by Quantum Mechanics.* **Lucy Mensing.** (Zeits. f. Physik, 36. 11 and 12. pp. 814–823, 1926.)—The quantum mechanics of Heisenberg, Born and Jordan are applied to the case of a rotating anharmonic oscillator which corresponds to the classical model of a diatomic molecule omitting the angular momentum of the electrons. The Hamiltonian function employed is $H = \frac{1}{2m_0}[p_x^2 + p_y^2 + p_z^2] + U(r)$, where $\frac{1}{m_0} = \frac{1}{m_1} + \frac{1}{m_2}$ and $U(r)$ is the potential energy. A perturbation proportional to $\lambda$ is introduced to evade degeneration, but the case actually considered is for $\lambda$ vanishingly small. The results for the frequencies in the bands conform to those of the classical quantum theory (using half-quantum numbers) as regards the pure vibration and pure rotation terms, but differ in the term arising from the reciprocal action of vibration and rotation. The intensities of the lines are calculated, the formula obtained agreeing with that given by Fowler.
W. S. S.

**2022.** *Complex Character of the Quantum Mechanical Matrices.* **K. Lanczos.** (Zeits. f. Physik, 37. 6. pp. 405–413, 1926.)—In this mathematical paper it is shown how a purely real formulation of recent theory [see Abstracts 1229 and 1230 (1926)] can be obtained in which the investigated matrices $p$ and $q$ are considered as real symmetrical matrices, *i.e.* the contingent nuclear functions $p(s, \sigma)$ and $q(s, \sigma)$ as real symmetrical nuclei. The imaginary element and the Hermite character of the matrices first enter into the treatment through the chief axial transformation of the oblique symmetrical quantum matrix. The difficulty which arises when the diagonal sum of the Born-Jordan quantum matrix becomes infinite is overcome automatically in the real formulation, since here the diagonal terms entirely disappear. The necessity, however, arises of introducing a correspondingly negative series in addition to the positive series of the quantum numbers.
H. H. Ho.

**2023.** *Postulates of Matrix Quantum Dynamics.* **J. H. van Vleck.** (Nat. Acad. Sci., Proc. 12. pp. 385–388, June, 1926.)—Born, Heisenberg and Jordan in their matrix dynamics deduce the law of the conservation of energy and Bohr's frequency condition, taking as postulates the Ritz combination principle, the Hamilton canonical equations, the quantum conditions, and the commutability relations (these arise only when systems of more than one degree of freedom are considered). The author shows that if the Bohr frequency condition, the conservation of energy, the canonical equations, and the commutability relations are postulated, then the Ritz combination principle and the quantum conditions follow.
W. S. S.

**2024.** *The Relation between the Quantum Mechanics of Heisenberg, Born and Jordan and that of Schrödinger.* **E. Schrödinger.** (Ann. d. Physik, 79. 8. pp. 734–756, May 4, 1926.)—The starting-points of the Heisenberg quantum mechanics and the author's recently described "undulatory" or "physical" mechanics are very different, and it is very remarkable that these two new quantum theories agree with one another with regard to the known facts where they differ from the old quantum theory. The author shows that, in spite of the very different treatment employed in the two theories, there is a very intimate inner connection between them; from the formal mathematical standpoint one is really justified in speaking of the identity of the two theories. There appear to be advantages, however, in regarding "micromechanics" as a refinement of "macromechanics" rendered necessary by the smallness of the objects, atoms and electrons, concerned, and it seems to be very difficult to deal with problems relating to the collisions of atoms or molecules, α-particles and electrons exclusively in terms of such abstract conceptions as transference probabilities, energy levels and so on, as in the Heisenberg theory. The original paper should be consulted for the mathematical treatment of the problems involved. H. N. A.

**2025.** *Significance of the Ether-Drift Experiments of 1925 at Mount Wilson.* **D. C. Miller.** (Science, 63. pp. 433–443, April 30, 1926. Paper read before the Am. Phys. Soc., Dec., 1925.)—The Michelson-Morley experiment and subsequent repetitions are briefly reviewed, and the significance of the results obtained by Miller at Mt. Wilson discussed as in a previous paper [see Abstract 2438 (1925)]. The complete study of the results leads to the conclusion that there is a systematic displacement of the interference fringes corresponding to a constant relative motion of the earth and the ether at the observatory of 10 km. per sec., and that the variations in the direction and magnitude of the indicated motion are such as would be produced by a constant motion of the solar system in space with a velocity of 200 km. per sec. towards an apex in the constellation Draco, having R.A. 262° and declination + 65°. In order to account for these effects it is necessary to assume that the earth drags the ether so that the apparent relative motion at the point of observation is reduced to 10 km. per sec., and that this drag also displaces the apparent azimuth of the motion about 45° to W. of N. These results are in general agreement with those relating to the proper motion of stars determined by Wilson at Dudley Observatory, with the results of Campbell and Moore relating to the radial motions of the stars, with the results of Strömberg relating to globular clusters and spiral nebulæ, and with the work of Lundmark. They involve a considerable readjustment of theories of the ether and a modification of the accepted explanation of aberration. It is suggested that systematic differences in the so-called "constant" of aberration and in standard star places as determined at different observatories might be explained on the hypothesis of a variation in ether drift due to differences in the local coefficient of drag dependent upon altitude, local contour and the distribution of mountain ranges, etc. J. S. G. T.

**2026.** *Application of the Rigorous Quotient Theorem (in Tensor Analysis).* **A. Brown.** (Phil. Mag. 1. pp. 748–751, April, 1926.)—Attention is directed to the fact that in the application of the rigorous quotient theorem—*viz.* "that a quantity which on inner multiplication by *any* covariant or *any* contravariant tensor always gives a tensor is itself a tensor"—the multiplying tensor must be completely arbitrary. If the multiplying tensor be in any way restricted the theorem cannot be used, but in certain cases other inferences may be made. The theorem is illustrated by reference to Eddington's deduction that $A_{\mu\nu\sigma}$ is a 3-rank covariant tensor. J. S. G. T.

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**2027.** *The Relativity Theory of Plane Waves.* **O. R. Baldwin** and **G. B. Jeffery.** (Roy. Soc., Proc. 111. pp. 95–104, May 1, 1926.)—Eddington's extension of Weyl's relativity theory of the propagation of gravitational waves of small amplitude is further extended to the case in which the amplitude is not small. All the solutions obtained are exact. It is shown that when the amplitudes are not small, it is no longer true that any wave may be resolved into waves of Weyl's three types. Eddington's results, however, are still true for waves of finite amplitude; longitudinal-longitudinal and longitudinal-transverse waves are spurious, and transverse-transverse waves are propagated with the velocity of light. The theory of the propagation of plane transverse-transverse waves is shown to depend on the solution of a single differential equation with five dependent variables. There is a strong presumption that an infinite plane electromagnetic wave or pulse cannot be propagated without change of wave form. This result is probably attributable to the infinite character of the wave-front, and it is suggested that the fuller development of the relativity theory of light must come from the study of divergent waves. J. S. G. T.

**2028.** *Gravity Determinations.* **E. Soler.** (Washington Acad. Sci., J. 16. pp. 261–266, May 19, 1926.)—A report of gravity work at the International Geodetic and Geophysical Union, Madrid meeting, is given. The difficulty of prescribing a single type of instrument for different countries is recognised, and uniform standards for computing pendulum results were suggested. The gravity values are to be corrected according to the classical methods of Faye and Bouguer and also by the isostatic method recommended by Hayford and Bowie. Two new methods of measuring gravity were foreshadowed: one by means of special light waves emitted during the fall of a body, and the other based on an interferometer determination of the flexure of a quartz fibre. W. A. R.

**2029.** *Curved Space-time and Radiation.* **G. Y. Rainich.** (Nat. Acad. Sci., Proc. 12. pp. 244–247, April, 1926.)—Previous work by the author [*ibid.*, 10. pp. 124–127, 1924] has shown that in curved space-time Maxwell's equations necessitate that a certain vector $q$, determined by the curvature field, must have a zero curl. A non-zero value of the time component $q_t$ of $q$ at a point would correspond to periodic variations of the magnetic and electric forces of frequency $q_t/2\pi$, *i.e.* to monochromatic light. No simple space-time could be found making curl $q = 0$ and for which $q$ did not vanish. This last condition would seem to entirely exclude radiation from the space. The recent extreme forms of the quantum theory indicate, however, that a light impulse is similar to a moving material point, *i.e.* that regions of space-time where radiation is present are one-dimensional. The suggestion is made and discussed that the vector $q$ may be zero everywhere except on certain lines in the field which correspond to the light quanta. Several other aspects of the question are touched upon. W. S. S.

**2030.** *Experimental Science and World Geometry.* **A. C. Lunn.** (Science, 63. pp. 579–586, June 11, 1926. Paper read at joint meeting of Am. Phys. Soc. and Am. Assoc. for Adv. of Science.)—The principles of, and objections to, the theory of relativity are briefly discussed. The

view is developed that by a combination of an abstract chain of ideas with a scheme of instrumental meanings a theory may be developed to define a system of expectations which shall serve to arrange and interrupt observations. For purposes of supplying a standard of comparison and a terminology for communication it is not so important that a theory should be "true" as that it should be definite. The significance of pre-relativity physics from the point of view of these postulates and the subsequent development of the subject are discussed. It is suggested that electrical and optical theory and a rational physico-chemical theory of the varieties of matter will ultimately be aspects of a fine-scaled time-space geometry.
J. S. G. T.

## METEOROLOGY AND GEO-PHYSICS.

**2031.** *Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather.* **L. G. Garbett.** (Roy. Meteorolog. Soc., J. 52. pp. 161–168; Disc., 168–172, April, 1926.)—Historical *résumé.*

**2032.** *Science and the Earthquake Peril.* **E. L. Jones.** (Frank. Inst., J. 201. pp. 563–596, May, 1926.)—The increased peril arising from earthquakes on account of increased density of population and complexity of structure above and below ground is reviewed. In North America the exceptional number of severe earthquakes in regions believed exempt indicates the need for a country-wide study in addition to detailed investigation of local regions. For this instrumental records and non-instrumental reports are required to provide details regarding earthquakes, and a census and maps are needed to give estimates of earthquake expectancy. The measurement of crustal creep by geodetic survey provides an indication of increasing strain and the possibility of an earthquake, although some special conditions may finally be required to act as a trigger. Lastly, the place of the Government to complete and coordinate the work is examined.
R. S. R.

**2033.** *Four-Year Period in Earthquakes.* **H. H. Turner.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 226–244, Dec., 1925.)—The earthquakes in the International Seismological Summary (1913–1920) are discussed for the 3·986 cycle. It is found that the epoch of maximum activity travels round the earth from West to East in 12 cycles, though the travel is not uniform, and is especially abrupt at three meridians separated by 120°. There is no sensible latitude influence. The range of frequency is from 126 to 74.
W. A. R.

**2034.** *Dynamical Theory of Tides.* **H. Jeffreys.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 244–246, Dec., 1925.)—The mathematical characters of the differential equation for the difference between actual and equilibrium tides in an ocean of uniform depth are discussed.
W. A. R.

**2035.** *Tides on the North Siberian Shelf.* **H. U. Sverdrup.** (Geofysiske Publ. 4. 5. [75 pp.], 1926.)—The theory here worked out is based on observations of tides made during the drift of the *Maud* over the North Siberian Shelf, 1922–1924. It is usual to assume that tidal waves on these shelfs result from the interference of two long gravitational waves generated in adjacent ocean basins. The results of the expedition indicate that the case is not so simple, for (1) the currents do not run alternately, but within the whole region rotate clockwise; (2) the tidal currents are not uniform downwards, but phase, direction and velocity vary with depth; (3) the velocity differs considerably from that calculated on the simple theory. A new theory is therefore sought. The characteristics of long gravitational waves in a rotating field as well as in a resting basin are worked out and the effects of viscosity and eddy viscosity considered for two cases—an unlimited channel and a rotating disc. The theory fitted generally the conditions observed on the expedition [see next Abstract]. W. A. R.

**2036.** *Oceanographic Current-recorders.* **H. U. Sverdrup** and **O. Dahl.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 537–545, May, 1926.)—Two types of oceanic current-recorders used on the *Maud* expedition are figured and described. Both are propeller instruments. The simplest is suspended in a bifilar frame, which forms the plane of reference for the current. In the second a single wire suspension is used and the current direction is determined by a compass-needle [see preceding Abstract]. W. A. R.

**2037.** *The Age of the Earth.* **A. Holmes.** (Nature, 117. pp. 592–594, April 24, 1926.)—Joly's reductions of the estimates of the age of the earth are criticised. The argument from the salinity of the oceans if based on any uniformitarian view is unsound. The analyses of river waters are not accurate; the origin of the chlorine in sodium chlorine of the waters is mysterious, and recent glaciated areas are yielding more sodium than could have been the case in former geological periods. Joly also reduces the age on the ground of the variability of the lead-ratios from thorium minerals. Holmes points out that Joly draws from limited evidence, and that the variability of results from thorium as compared with uranium minerals indicates that the former tend to lose lead by solvent action. The lead in thorium minerals is probably present in a more soluble salt. The evidence is overwhelming against Joly's contention that the age as based on uranium ratios is four times too high [see next Abstract]. W. A. R.

**2038.** *The Age of the Earth.* **A. Holmes.** (Phil. Mag. 1. pp. 1055–1074, May, 1926.)—This paper gives a more detailed account of the evidence and arguments put forward in a previous one [see preceding Abstract]. W. A. R.

**2039.** *Earth History.* **H. Jeffreys.** (Phil. Mag. 1. pp. 923–931, May, 1926.)—Joly's theory of earth history is adversely criticised. Joly's assumed thickness for the granitic layer is probably excessive, and his result that the solid layer beneath the oceans is thinner than in the continents is erroneous. Tidal friction is inadequate to make the outer shell rotate over the interior. W. A. R.

**2040.** *Deposition of Water-vapour from the Atmosphere and Isostasy.* **P. G. Nutting.** (Washington Acad. Sci., J. 16. pp. 254–258, May 4, 1926.)—The quantity of water present on the earth's surface is sufficient to contribute a pressure of 252·3 atmos. to the atmospheric pressure if it were all vapourised. Since this is above the critical pressure (217·8), as the cooling earth passed the critical temperature of water at 374° C., 13·7 % of the water would be precipitated, forming a layer of average depth 357 metres. Local pressures may have amounted to 3000 ft. of water. The chemical activity of water at these temperatures and pressures would have been very great. A table is given showing the percentage precipitated and the temperature. The assumption usually made that above 100° C. there would be complete dryness is entirely contrary to facts. More generally the complete succession of stages of the formation of the earth's crust is followed through. Summarised this may be given as: Above 5000° C.: Pressure 20–30 tons/in.². No solids. 4800–4600° C.: Few metallic carbides form. Atmosphere 90 % oxygen. Pressure maintained. 4600–3000° C.: No great change in conditions. Liquid alloys present. 3000–2000° C.: Period of oxidation. Mostly molten with water-vapour atmosphere. Pressure drops to 3 tons/in.² in consequence of removal of oxygen. Superficial layer of oxides prevents all oxygen being removed. Water limited by available hydrogen. 2000–400° C.: No great change. Carbides and metals deeply buried by silicate minerals. 374° C.: One-seventh of the water precipitated as liquid. Pressure falls from 3700 to 3200 lbs./in.². 374–300° C.: Great period of chemical action by water. Ocean increased to two-thirds of its present volume. Torrential rain of high-temperature water produces enormously rapid erosion with correspondingly rapid sedimentation. A. Wh.

**2041.** *Isostasy.* **G. R. Putnam.** (Washington Acad. Sci., J. 16. pp. 285–291, June 4, 1926.)—An historical account is given of the methods that have been adopted for reducing gravity observations. W. A. R.

**2042.** *Changes in the Rate of Rotation of the Earth.* **E. W. Brown.** (Nat. Acad. Sci., Proc. 12. pp. 406–413, June, 1926.)—A summary of a paper to appear shortly. The astronomical evidence for changes in the rate of rotation of the earth is surveyed and collated. Most of the useful data are derived from variations of unknown origin in the moon's motion. It is concluded that there is good evidence that the observed deviations are due to changes in the rate of the rotation of the earth, and correlations are traced between the irregularities and some seismic observations. It is concluded that the changes in the rate of rotation must be due to forces below the surface crust of the earth causing a general vertical oscillation and some consequent isostatic local variations. The maximum change of the average radius is from 5 in. to 12 ft. according to the depth of the source of the disturbing force. The results indicate that oscillations of periods measured in years and in centuries occur, and that the depth of the origin is 80–90 km. A recent theory advanced by Joly postulated depths of 30 km. and a period of the order of geological periods. A. Wh.

**2043.** *Geophysical Methods in Prospecting.* **R. Ambronn.** (Terrest. Mag. 31. pp. 1–7, March, 1926. Abstract.)—Geophysical methods for prospecting for minerals, oil, etc., are now systematically employed. They depend on the fact that the subsurface materials and geological structure affect the spatial distribution of gravity, magnetic and electric phenomena on the earth's surface. Methods divide themselves into two groups. The first depends on the physical properties of those elements which are able to exert direct action at a distance, *e.g.* gravity forces and magnetic fields. The second group includes the properties which indirectly influence the development and spatial distribution of energy currents passing naturally through the earth. This group includes electric and thermic methods of investigation. Caution is needed, for like surface-distributions may in some cases result from unlike subsurface conditions.

W. A. R.

## ASTRO-PHYSICS.

**2044.** *Source of Stellar Energy.* **A. S. Eddington.** (Nature, 117. pp. 25–32, May 1, 1926. Supplement. Lecture delivered at King's College, Univ. of London, March, 1926.)—A far greater age is demanded for the sun by radio-active considerations and by the evolution of the lunar system than is afforded by the Helmholtz-Kelvin contraction hypothesis. Similarly the rate of change of period of certain Cepheids is too small to allow the rate of increase of density demanded by it. In the case of the sun, an age of $10^{10}$ years will be necessary to fit in with observations. Further, the supply of energy will not avail at the surface of a star, but must be capable of maintaining the very great temperature gradient between it and the centre. Energy must become available in the deeper layers of the star. This generation of energy is probably taking place at the expense of mass, and two possibilities exist: The energy may be the result of the mutual destruction of a proton and electron, or of the transmutation of elements. The energy due to transmutation is a small fraction of the total mass. When helium is formed from hydrogen, 0·8 % of the mass is transformed into energy, this representing the departure of the atomic weight of hydrogen from unity. Since higher transmutations cause a much smaller mass change, it is probable that not more than 1 % of the total mass of a star can be made available as energy. The fact that stars with higher temperature and density liberate less energy than stars where the physical conditions are less extreme seems to point to the conclusion that the supply of energy is inexhaustible. Even then the case of the components of spectroscopic binaries is difficult to explain. With regard to the conditions necessary to allow the observed degradation of mass, it is pointed out that in the "Main series," from types O to M, there is an approximately constant central temperature of about 40,000,000° over a wide range of rates of energy supply. The inference seems to be that at this temperature energy is freely evolved "as steam issues from water at 100°." Such an hypothesis would account for pulsating stars, a star during contraction raising more of its mass above the critical temperature and so expanding again with a larger balance of free energy. Unfortunately the Cepheids are at just the wrong position in the evolutionary series to support this theory. The theory of evolution by loss of mass is supported by the fact that the young stars have a much larger average mass than the older ones, but the co-existence of large and small stars in certain star clusters is distinctly against it. The penetrating radiation demonstrated by Kolhörster and Millikan is discussed. Its wave-length appears to necessitate its sub-atomic origin, and it seems to prove that violent sub-atomic processes can occur at temperatures below 100,000°. Also the density essential must be extremely low, and it is difficult to imagine the possibility of sufficiently frequent collisions to produce any effect at all. At present many of the ideas which seem necessary consequences of the astronomical observations are extremely difficult to reconcile with physical probabilities. A. Wh.

**2045.** *Diffraction of the Solar Image by a Rectangularly Stopped Lens.* **M. Hamy.** (Comptes Rendus, 182. pp. 1105–1108, May 10, 1926.)—In a previous communication [Abstract 1792 (1926)] on this subject was introduced an integral :—

$$J_{2\sigma} = -\int_{c}\frac{(1-u^2)^{\sigma-\frac{1}{2}}}{(u-a)^2}du\int_{y}\frac{(1-z^2)^{\sigma}}{z^2}\cos(2nz\sqrt{1-u^2})dz$$

In the present paper, which is entirely mathematical, this integral is developed in terms of a series of sums involving $\Gamma$ functions. A. Wh.

**2046.** *Visual Observations of Solar Phenomena.* **G. E. Hale.** (Nat. Acad. Sci., Proc. 12. pp. 286–295, May, 1926.)—The spectrohelioscope, an instrument for observing the sun in monochromatic light, has been described in a previous article. It has now been mounted in the new Solar Laboratory in Pasadena, and the author briefly indicates its varied uses. It is an excellent scouting auxiliary to the spectroheliograph and spectrograph, making it possible to glance rapidly and frequently over the sun and detect the beginnings of rare or fugitive phenomena; and owing to the ease with which every part of a wide line such as H$\alpha$ can be successively examined, all aspects of spots and faculæ, prominences and absorption markings can be studied in detail, and the connections between these phenomena and their relations with terrestrial phenomena can be traced. H$\alpha$ shows them best, but other lines have been used, such as the D and the *b* lines, and a few of iron. The instrument should prove useful also in the laboratory for the study of arcs, sparks and other light sources with lines of various types. M. A. E.

**2047.** *Unknown Bodies in the Solar System.* **N. Boneff.** (Bull. Astronomique, 5. 2. pp. 219–222, 1925.)—The existence of considerable masses of material in the solar system in the form of meteorites or similar particles is discussed. If they are considered to be the vestiges of an early diffuse solar system their distribution will have been affected by the planetary orbits and conditions of capture. The probable effect on the distribution of such bodies is discussed, and it is considered that Moulton's conclusion that there are not enough meteorites with the correct initial conditions to agree with Gylden's theory of the Gegenschein is contradicted by the consequences of the author's theory. A. Wh.

**2048.** *Comparison of the Greenwich and Photographic Positions of the Moon,* 1911–1917. **E. W. Brown.** (Astron. J. 36. No. 860. pp. 153–155, May 12, 1926.)

**2049.** *Motion of the Perihelion of Mercury.* **J. Chazy.** (Comptes Rendus, 182. pp. 1134–1136, May 10, 1926.)—Three sets of figures for the advance of the perihelon of Mercury are compared. Newcomb did not reckon the longitude of perihelon according to the usual definition, and his results need correction by a term $2 \sin^2(i/2) \, . \, d\Omega/dt$. Applying this correction and using Newcomb's values for the masses, the figures given for the total advance of the perihelon by Newcomb, le Verrier and Doolittle are $529''\cdot 22$, $529''\cdot 40$ and $529''\cdot 2117$. The agreement is extremely close. The observed value is not reliable. Newcomb gives $\epsilon . \delta\omega = 110''\cdot 24$, corresponding to an advance per century of $572''\cdot 70$. The difference between these values is then $43''\cdot 49$. A. Wh.

**2050.** *Problems of Latitude.* **J. Mascart.** (Bull. Astronomique, 5. 2. pp. 147–184, 1925.)—This is a comprehensive survey of the work which has been done to determine variations of latitude in many observatories throughout the world since variation was first suspected in 1820. The research is most delicate and difficult, because it involves a rigorous determination of all instrumental constants; but of recent years the precision of observations has greatly increased, and the results of different astronomers, using different stars, different instruments and different methods, agree so well that it has been proved beyond doubt that all localities are subject to variation of latitude. In many ways, however, the problem becomes more complicated as research progresses, and the question arises whether the work should be continued, or suspended, in order to carry out more urgent inquiries, until further improvements in method have been attained. M. A. E.

**2051.** *A Spiral Nebula as a Stellar System.* **E. Hubble.** (Mt. Wilson Observat. Contrib. No. 310. Astrophys. J. 63. pp. 236–274, May, 1926.)—The nebula M33 is visible to the naked eye, being only a little fainter than the great Andromeda nebula, which suggests that it is probably one of the nearest of the spiral nebulæ. Photographic investigation indicates that it is a distant system of stars and nebulæ, scarcely comparable in size with our galactic system, but similar in this and other respects to the Magellanic Clouds. The distance, as derived from thirty-five Cepheid variable stars discovered in it, is about eight times that of the small Magellanic Cloud, or 263,000 parsecs. This is confirmed by evidence from two Novæ and several patches of emission nebulosity with blue stars involved. It differs from the Clouds in that the majority of at least the brightest stars are of early spectral types, and that there is a symmetrical arrangement of material with regard to a dominating nucleus. The paper is illustrated by four plates and a number of diagrams. M. A. E.

**2052.** *Ionisation in Giant and Dwarf Stars.* **H. N. Russell.** (Harvard Coll. Obs., Circ. 291. [4 pp.], 1926.)—Considering the lines characteristic of dwarf and of giant spectra, it has been found that generally giant star spectra indicate an increase in the intensity of enhanced lines even for those for which the maximum intensity occurs at a much lower temperature in the spectral series, though it would appear as if an increase in ionisation due to rising temperature should increase the second ionisation of the element and thereby diminish the intensity of its enhanced lines as well as its arc lines. The author explains this by means of the equation: $\log r = \log x_1/x = -\,5040\ \mathrm{I/T} + 5/2 \log \mathrm{T} - \log \mathrm{P}e - 6\cdot 5 + \log u_1/u$, where the logs are to the base 10; $r$ is the ratio of the number of atoms $x_1$ in the more highly ionised state to the number $x$ in the next preceding state; I is the ionisation potential (in volts) for this transition; T the absolute temperature; P*e* the "electron pressure" in atmospheres;

and $u_1$, $u$ the statistical weights of the normal states of the ionised and neutral atoms. Comparing the equations for two stars, he obtains quantities A, B and $I_0$; [$B/A = -I_0$; $\log r'/r = A(I - I_0)$], which depend only on pressures and temperatures, and are the same for all constituents of the gas. Taking corresponding points in the atmospheres of a dwarf and a giant star, if $I_0$ lies between the first and second ionisation potentials of any element, the first ionisation of that element will be encouraged in the giant and the second repressed, both of which tend to increase the intensity of the ultimate enhanced lines. In the dwarf, the repression of the first ionisation will increase the strength of the lines of the neutral atom. The value of $I_0$ he finds as probably between 10 and 12 volts. He applies this equation to the G and K5 class stars, and obtains temperatures for the giants and dwarfs in these classes as 5400°, 4800° and 4000°, 3430°, as compared with Seares' values of 5500°, 4600° and 4120°, 3270° respectively, thus giving a difference in colour between giants and dwarfs of about two-thirds that observed by Seares, which is not an extravagant disagreement. A. S. D. M.

**2053.** *Inclination of Orbits of Spectroscopic Binaries.* **G. Shajn.** (Roy. Astron. Soc., M.N. 86. pp. 543–548, May, 1926.)—In order to discover whether the planes of the orbits of spectroscopic binaries have any peculiar distribution in space, their mass-function $(m_1 + m_m) \sin^3 i$ has been investigated and compared with their galactic latitude. For this purpose Moore's new Third Catalogue of Spectroscopic Binary Stars [see Abstract 955 (1926)] has been used, but binaries with very uncertain orbits have been excluded, and also all Cepheids and stars with periods shorter than 2·3 days, since O. Struve has shown that it is doubtful whether these are true binaries. It appears that the mass-function decreases with increasing galactic latitude, and it is probable that the distribution of the orbital planes is not random, but that there is a tendency for them to be parallel to the Galaxy. M. A. E.

**2054.** *Origin of Bright Lines in Stellar Spectra.* **S. Rosseland.** (Mt. Wilson Observat. Contrib. No. 309. Astrophys. J. 63. pp. 218–235, May, 1926.)—The discussion distinguishes four principal cases: (1) A star in hydrostatic and radiative equilibrium in which the emission of radiation from any small portion of matter corresponds to the case of true temperature equilibrium would show absorption lines over the main stellar disc, while the atmosphere projecting outside the disc would show emission lines. (2) Owing to general atomic properties, the thermal state of matter assumed in (1) can only be realized in nature provided the pressure and temperature exceed certain limits. Below these limits (*i.e.* in the outer parts of the stellar atmospheres) fluorescence comes into play, manifesting itself all over the stellar disc, and it is suggested that bright-line emission in early-type stars is due to such causes. (3) Any kind of penetrating radiation (*i.e.* in the nature of α-, β-, or γ-rays) entering the atmosphere must produce bright-line radiation, as shown, for instance, in the case of the terrestrial aurora borealis. (4) If the hydrodynamic state of the atmosphere is far from a state of hydrostatic equilibrium, local regions of high temperature may be formed in the atmosphere, which necessarily must give rise to bright-line emission. It is tentatively suggested that bright lines in late-type spectra owe their origin principally to such causes as are enumerated under (3), or possibly (4); the strong excitation of the gases concerned would seem to exclude (2), while (1) is excluded by the low density of the stars in question. AUTHOR.

**2055.** *Effect of Star's Colour upon its Photographic Position.* **F. Schlesinger.** (Astron. J. 36. pp. 169–172, June 2, 1926.)—For the re-observation of the equatorial zone of the Gesellschaft Catalogue at Allegheny, 602 comparison stars have been used to calibrate the plates which were exposed at an average zenith distance of 42°. These stars were also observed visually with the Lick meridian circle, and the author has collected the differences in declination between the two sets (in the sense, photographic *minus* visual) according to spectra, so as to bring out the dependence of the star's photographic position on its class of spectrum, this dependence being proportionate to the tangent of the zenith distance. He finds a steady progression in the mean differences, the blue light of B and A stars being more refracted than the red. He translates these differences in declinations into differences of effective wave-length, agreeing in general with other recent determinations, but showing a smaller range (probably due to absorption by Allegheny smoke). He explains why the differences in effective wave-lengths are exaggerated for long exposures as compared with short, or for bright stars as compared with faint, by the atmosphere's conversion of every star image into a spectrum, the blue end of which is uppermost, and its length nearly proportionate to the tangent of the zenith distance, and he shows that for white stars (class B or A) the image grows more towards the zenith than towards the nadir with increase of exposure or brightness; and for yellow stars, the falling off towards the lower end is not much more abrupt and may be less than towards the upper end, so that there is little creeping upwards for prolonged exposures on yellow and red stars. The neglect of atmospheric dispersion may lead to appreciable systematic errors in the average motions of very white or very red stars, and of bright stars as compared with faint. He considers the result from the point of view of trigonometric parallaxes, and advises observers to use some device to equate the magnitude of the parallax stars with the comparison stars, or better still, to determine experimentally certain relations for their telescope, and thus correct the parallax observations. A. S. D. M.

**2056.** *The Next Task of Astronomy.* **R. A. Sampson.** (Nature, 117. pp. 725–727, May 22, 1926. Paper read before the Optical Convention, April, 1926.)—The total radiation from a star and the shape of its spectral intensity curve may be measured bolometrically (as by Abbot and Coblentz), but this method is of limited application; and the visual estimation of stellar magnitudes (the chief standard being the North Polar Sequence of Pickering) relates to a mixed phenomenon, the physical interpretation of which cannot be analysed. The most promising path to further progress lies in the study of the photographic deposit, with the view of providing photographic photometry with an exact interpretation. C. W. H.

## LIGHT.

**2057.** *The Nature of Light.* **R. C. Tolman** and **S. Smith.** (Nat. Acad. Sci., Proc. 12. pp. 343–347, May, 1926.)—A discussion of the views put forward by Lewis [see Abstract 972 (1926)]. It is pointed out that the proposed crucial experiment to test the action of quanta in interference effects might yield very different results from those expected by Lewis and give at best a second-order effect. It is then suggested that light waves act as a signalling system to atoms so that they may know when they may interact with an oncoming quantum. F. S.

**2058.** *True Signification of Fizeau-Zeeman's Experiments.* **C. L. R. E. Menges.** (Phil. Mag. 1. pp. 1198–1201, May, 1926.)—The present paper contains a discussion of the result of a former investigation [see Abstract 1614 (1925)] in which it was shown that the usual interpretation of Fresnel-Fizeau's experiment is essentially erroneous on account of two subtle errors, which depend on each other and which formerly were unconsciously introduced. The author now carefully reviews the various stages of his former treatment to afford an emphasis of his standpoint and to correct previous misunderstanding. By this means he claims to rehabilitate the importance of Fizeau's experiment, which in certain respects much surpasses that of Michelson and Morley. Zeeman's experiments are found to confirm the author's equation practically to 100 %, and Einstein's theory is held to be untenable. H. H. Ho.

**2059.** *Repetition of the Harress-Sagnac Experiment.* **B. Pogány.** (Ann. d. Physik, 80. 3. pp. 217–230, June 2, 1926.)—This investigation relates to the Harress experiments published in 1911 on the propagation of light in a rotating glass body, and analogous work by Sagnac [see Abstract 1506 (1914)] for air instead of glass. Harress's theory was later corrected by Harzer and Einstein and the entire theoretical treatment brought into connection with the Fizeau and Zeeman investigations by v. Laue. The present paper first reviews these theoretical conclusions and then describes the original apparatus of Harress with suitable modifications and additions to afford more exact results from the experiments. From the published data the author concludes the deviation between the calculated and observed average band displacements to be somewhat great for good agreement between the separate observations. The paper consists almost entirely of experimental details, for which it should be consulted. H. H. Ho.

**2060.** *Transition Probabilities : Their Relation to Thermionic Emission and the Photoelectric Effect.* **E. O. Lawrence.** (Phys. Rev. 27. pp. 555–561, May, 1926.)—Assuming (*a*) Wien's formula for black-body radiation, (*b*) that electrons ejected thermally from a hot body have the experimentally known Maxwell distribution of velocities, and (*c*) that photoelectric emission from a solid surface is independent of the temperature of the solid, a theory is developed in this paper which leads directly to Richardson's thermionic current equation without importing into the

argument circumstances not realised in experiment or assumptions and approximations that can be questioned. Detailed consideration of the mechanism of emission and absorption along the lines of Einstein's derivation of Planck's radiation formula leads to the same expression for the ratio of absorption to emission $B_v/q_v$ in other theories based on application of the principle of detailed balancing of processes occurring in systems in equilibrium. It is thus shown that observed photoelectric and thermionic phenomena from solid surfaces may be regarded as experimental confirmations of expressions $B_v/q_v$ deduced in such theories.
H. H. Ho.

**2061.** *An Optical System for Reading the Angular Deflection of a Mirror.* (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 529–536, May, 1926.)—With the usual lens, mirror and straight scale method of reading deflections, the indicated value is proportional to the tangent of the angle of deflection. In many instruments (for example in extensometers, in which the motion is communicated to the mirror by the rolling of the axis of the mirror or by a pinion and geared sector) a deflection on a plane surface proportional to the angle of deflection is desirable. This is particularly true if deflection is registered on a moving photographic film, as it gives an equicrescent scale in each direction. A simple two-lens system which can be satisfactorily made on standard spectacle tools has been designed which introduces distortion sufficient to give desired relation between deflection and indicated value and at the same time gives notable flattening of field, thus permitting the photographic registry of very large deflections. Other simple relations between deflection and indicated value may be secured by the re-design of the projecting system.
AUTHOR.

**2062.** *Interferometric Constant Deviation Prism.* **H. Nagaoka** and **T. Mishima.** (Imp. Acad. Tokyo, Proc. 2. pp. 156–157, April, 1926. In English.)—The instrument was designed for examining the structure of spectral lines without the use of a monochromator and for crossing the spectra obtained with the Fabry-Perot interferometer with those from the Lummer-Gehrcke plate or echelon grating. In crossing the spectra the loss of light due to the introduction of a system of lenses is much avoided, and the structure of faint lines can be dealt with more easily. The required photographic exposure will thus be decreased and the results made more trustworthy. Illustrations are given of spectrograms of Hg lines.
R. S. R.

**2063.** *A New Technique in the Use of Gratings for the Study of the Millikan Region of the Ultra-violet.* **J. Thibaud.** (Comptes Rendus, 182. pp. 1141–1143, May 10, 1926. Rev. d'Optique, 5. pp. 97–107, March, 1926.)—By working at a grazing incidence X-ray diffraction-spectra have been obtained with gratings ruled with only 200 lines per mm. The same device has now been used to study the radiation down to 144 Å.U., which Millikan investigated with gratings containing 500 to 1100 lines per mm. It is therefore likely that the same device can be used to bridge the gap between 10 and 150 Å.U.
T. M. L.

**2064.** *Reply to the Remarks of P. Heymans on the Work of A. Ramspeck.* **W. König.** (Ann. d. Physik, 79. 8. pp. 757–760, May 4, 1926.)—This is a reply to some remarks made by Heymans on the work of Ramspeck on "Anomalies of Accidental Double-refraction with Celluloid." [See Abstract 2666 (1925).] A. E. G.

**2065.** *Optical and Electric Constants of Cane Sugar.* **E. L. Palumbo.** (Ann. d. Physik, 79. 6. pp. 533–549, April 6, 1926.)—A consideration of the measurements of the optical and electric constants (refractive index, rotation of polarisation, dielectric constant, etc.), and their dependence on dilution, wave-length, temperature, etc., with a view to obtaining some characteristic constants. It is thought that these will throw some light on the way the molecule is built up from positive and negative charges. **R. Gans** adds a note on the theory of rotation polarisation in which he develops farther a former criticism of Born's theory. J. E.

**2066.** *Polarisation of Light in Turbid Media. Part I.* **G. I. Pokrowski.** (Zeits. f. Physik, 36, 7. pp. 548–556, 1926.)—In turbid media of high concentration and scattering power the polarisation of the scattered light depends upon the properties of the scattering element, the angle of observation and upon the thickness and concentration of the layer. A theoretical treatment is given and is confirmed for experiments on suspensions of milk, soap, aluminium hydroxide, cadium sulphide, and gypsum. W. H. Ge.

**2067.** *Coherence and Consonance of Light.* **M. Berek.** (Zeits. f. Physik, 36. 11–12. pp. 824–838, 1926.)—Continuation of research on the subject [see Abstract 1807 (1926)]. Works out a complete theory for interference with great path-differences. Discusses the results obtained. A. D.

**2068.** *Interference by Multiple Reflections.* **L. Gilchrist.** (Phys. Rev. 27. pp. 596–605, May, 1926.)—A theoretical paper dealing with the resolution of the components of a source of radiation by the Michelson method of visibility of interference fringes. Approximate expressions are derived for the intensity and visibility of fringes for both transmitted and reflected light when any number of multiple reflections exist and the source of light is one of small width. The effects of the coefficients of reflection and absorption are examined, and it is indicated that the method of visibility with interferometers which depend on multiple reflection may be used in the study of the fine structure of such spectra as those of hydrogen and helium to give both the components and their character. W. H. Ge.

**2069.** *Greater Dispersion in the Extreme Ultra-violet.* **R. J. Lang** and **S. Smith.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 523–528, May, 1926.)—The construction and operation of an optical vacuum grating spectrograph capable of accommodating a grating of 2 metres radius is described. Means are provided for introducing and removing the photographic plate as well as altering the focus and the inclination of the grating while the vacuum is maintained. The following doublets in Fowler's series have been resolved and the frequency separation measured: $(2\pi_1 - 3\sigma)(2\pi_2 - 3\sigma)\Delta\nu = 64$ in the second order of the grating and 60 in the third order; $(2\pi_1 - 3\delta)(2\pi_2 - 3\delta)\Delta\nu = 64 \cdot 5$ in second order. For lines $\lambda = 1335 \Delta\nu = 65$ and for lines $\lambda = 1036 \Delta\nu = 62$, showing that since the 1036 line belongs to $C_{II}$ probably 1335 does also. In Si III the following doublet is resolved: $(3\sigma_1 - 4\pi)(3\sigma_2 - 4\pi)\Delta\nu = 153$. **A. D.**

**2070.** *Polarisation of Light in Sulphur Suspensions.* **G. I. Pokrowski.** (Zeits. f. Physik, 37. 3. pp. 172–178, 1926.)—An experimental investigation of the polarisation of light in sulphur suspensions as a function of the size of the particles and of the angles of deviation. With sulphur suspensions produced by the action of sulphuric acid on an aqueous solution of hypophosphite and showing a gradual increase in the size of the particles an inversion of polarisation is observed. This can be explained on the basis of Rayleigh's theory of the dispersion of light in turbid media. On the other hand, the dependence of the polarisation of the dispersed light on the angle of deviation is in contradiction with theory. This contradiction can be qualitatively explained by the irregular shape of the suspended particles. **E. F.**

**2071.** *Photophoresis.* **G. Hettner.** (Zeits. f. Physik, 37. 3. pp. 179–192, 1926.)—Deals with the theory of the motion of illuminated particles. Consideration is given to the case of high pressures, when the free path of the particle is small compared with its radius, and also to the case of ordinary pressures when the free path and the radius of the particle are of the same order. For usual values of the radius of the particles, the photophoretic force is a maximum at atmospheric pressures consistent with the small dependence upon pressure found in this region. The limits of the independence upon the nature of the gas are indicated for the given experimental conditions. The paper is chiefly theoretical. **W. H. Ge.**

**2072.** *Photography in Daylight of Exploding Shells with Photogenic Charges.* **M. Paul.** (Rev. d'Optique, 5. pp. 119–129, March, 1926.)—The photogenic action is produced by the explosion of a mixture of black powder and magnesium, 100 gm. about; the photography by night of the luminous point produced by the explosion of the shell is then very easy, but in daylight the problem is much more difficult. To obtain upon the plate the flash of the explosion it is necessary to take into consideration (*a*) the very short duration of the flash, about 2/100 sec., and (*b*) the fact that the objective of the registering apparatus must be open about one second before the explosion, and so the plate will be exposed to the sky 50 to 100 times longer than to the explosion. The first effectual attempts are described in this paper. **A. E. G.**

**2073.** *New Reflection Densitometer.* **H. M. Cartwright and C. D. Hallam.** (Journ. Sci. Instruments, 3. p. 246, May, 1926.)—A simple self-contained instrument is described for measuring the densities of photographic or half-tone prints. **Author.**

**2074.** *Colour-sensitivity of Photographic Materials.* **C. E. K. Mees.** (Eastman Kodak Co. Research Lab. Comm. No. 262. Frank. Inst., J. 201. pp. 525–551, May, 1926.)—A general survey of the subject is here given. Curves given show: Sensitiveness of silver chloride in collodion; absorption and sensitiveness of silver bromide containing silver iodide; wave-length sensitivity curves of plates; relation between contrast and wave-length. Other illustrations show: Ultra-violet spectra on (*a*) ordinary plate, (*b*) a plate treated with mineral oil. Wedge spectra of plates treated with various sensitisers; diagram of wedge spectrograph; wedge spectra of plates sensitised for the infra-red; diagram showing progress in recording the spectrum; photograph taken by infra-red rays; photographs taken by long-wave radiation; comparative photographs of Mars taken with an ordinary plate and an extreme red-sensitive plate with filter. A. E. G.

**2075.** *Desensitising Colour-sensitive Plates.* **A. Hübl.** (Zeits. Wiss. Phot. 24. pp. 133–139, May, 1926.)—In desensitising colour-sensitive plates the effect is due to action of the desensitiser upon the coloured sensitiser, not upon the bromide of silver. A. D.

**2076.** *Colour-sensitiveness of Silver Haloids and the Action of Sensitisers.* **J. M. Eder.** (Zeits. Wiss. Phot. 24. pp. 139–144, May, 1926.) Gives a tabulated statement of the action of the most important sensitisers. A. D.

**2077.** *Conditions governing the Behaviour of Silver Bromide Grain during Development. Part II.* **L. F. Davidson.** (Phot. J. 66. pp. 230–240; Disc., 240–242, May, 1926.)—This is a continuation of a previous paper [see Abstract 1354 (1925)] on the microscopic study of development. The previous results are confirmed and amplified. Several improvements in detail of the apparatus have been made, notably in the design of the micro-camera. E. G.

**2078.** *Valuation of Reception with the Lummer Plate.* **P. Kunze.** (Ann. d. Physik, 79. 6. pp. 528–532, April 6, 1926.)—It is claimed that for simplicity and accuracy the method here described is superior to all others. It is necessary for its use that there should be no image errors produced by the camera lens. A suitable definite fixed point from which to number the wave-lengths is a characteristic of the method. The accuracy of the method appears high. A. E. G.

**2079.** *Measurements of Photographic Density.* **W. B. Ferguson.** (Phot. J. 66. pp. 294–297; Disc., 297–298, June, 1926.)—Joy's contact printing density $D_\phi$ (*ibid.*, 64. p. 169, 1925) and the density $D_H$ as read in a density-meter of the contact-opal type are proportional to one another; $D_\phi = 0\cdot92D_H$ for the ordinary contact opal type, and $= 0\cdot95D_H$ for the "F.V." metre. [See Abstract 1333 (1924).] A. D.

**2080.** *Relation between Colour-sensitiveness and the Gradation given by a Photographic Plate.* **T. T. Baker** and **W. A. Balmain.** (Imperial Dry Plate Co. Research Lab. Comm. No. 20. Phot. J. 66. pp. 299–304; Disc., 304–306, June, 1926.)—A good deal of difference of opinion exists as to the actual effect upon the gradation or contrast of a negative caused by the colour of the light in which it has been exposed. It is generally thought that with change of wave-length some change of gradation takes place. Various changes in gradation or gamma bearing no apparent relationship to wave-length have been recorded by several workers. In a communication to the Faraday Society in 1923 one of the present authors stated that for certain plates gamma infinity remains constant for all wave-lengths, at any rate between $\lambda = 1 \cdot 8$ Å. and 7000 Å. This statement has since been laid open to doubt by the work and statements of other investigators. It is now hoped to show that when dealing with a single silver halide this statement is correct, and that the discrepancies between the results of various workers in change of gamma with wave-length has been due to a lack of information of some of the fundamental points involved. A number of experiments is carried out in order to determine, if possible, what was responsible for the apparent variation in gradation that had been observed by different workers. A. E. G.

**2081.** *Spectral Sensitivity of Silver Iodide and of Mixtures of Silver Iodide and Silver Bromide.* **E. Huse** and **C. E. Meulendyke.** (Eastman Kodak Co. Research Lab. Comm. No. 267. Phot. J. 66. pp. 306–309, June, 1926.)—The silver halide used in photographic emulsions of the type employed for making negatives is silver bromide containing a small proportion of silver iodide, the amount of iodide usually ranging from 1 to 10 % of the total silver salt. It is well known that the colour and the spectral sensitivity of the emulsions depend upon the proportion of iodide present, and in 1890 Abney and Edwards made an extensive study of the salts of silver and showed that the addition of 5 % silver iodide to silver bromide emulsion shifted the spectral sensitivity toward the green. In a preliminary study of the spectral absorption and spectral sensitivity of silver bromide emulsions containing silver iodide, it is found that the absorption shows a progressive shift towards the longer wave-lengths with increasing amounts of silver iodide, and that the spectral sensitivity shows the same effect. This shift of the absorption with increasing iodide is observed to continue until the emulsion contains 30 to 40 % iodide. A series of emulsions is made in which the proportion of iodide varies from 0 to 100 % in uniform steps, and it is found that with physical development a sharp sensitiveness edge at 440 $m\mu$ can first be observed with 32 % iodide; it is very visible with 35 % iodide and entirely lacking with 30 % iodide; it may, therefore, be concluded that silver iodide separates in emulsions of this type as definite crystals apart from the silver bromide, when the silver iodide content reaches approximately 32 %. A. E. G.

**2082.** *Grain Size and the Quantum Theory of Photographic Exposure.* **M. C. Hylan.** (J. Phys. Chem. 30. pp. 845–848; Disc., 848, June, 1926.)—In a paper entitled "Dispersity of Silver Halides in Relation to their Photographic Behaviour" [see Abstract 1781 (1924)] it was shown by the author and F. E. E. Germann that, theoretically, fine-grained photographic emulsions ought to be faster than coarse-grained ones, although in practice the order of sensitivity seems usually the reverse. This discrepancy between theory and fact is explained on the basis of adsorption of retarding soluble halide, the fine-grained emulsions adsorbing relatively more than the coarse-grained ones, and thus reversing the purely dimensional effect. The experimental evidence offered by Germann and Hylan in support of their theoretical conclusions as to the relation between grain size and sensitivity in photographic emulsions might be regarded as merely "circumstantial." Direct evidence in support of their conclusions can be obtained only by a comparison of emulsions known to be free of all adsorbed "impurities," either retarding or accelerating. The quantum theory of photographic exposure as expounded by Silberstein combined with the assumption that a silver halide grain is rendered developable by the absorption of a single light quantum, was shown by Rawling to lead to conclusions directly opposed to those of Germann and Hylan. The theory of Germann and Hylan is here shown to be more in accord with known facts and principles of photo-chemistry than is that of Rawling and of Silberstein. Emulsions free of adsorbed impurities have been prepared and their speeds compared, with results which support the theoretical conclusions of Germann and Hylan. A. E. G.

**2083.** *Use of Arcs and other Fluctuating Sources in Photoelectric Photometry.* **B. Kurrelmeyer.** (Nature, 117. pp. 657–658, May 8, 1926. Science, 63. pp. 640–641, June 25, 1926.)—In his paper on the registering microphotometer, P. P. Koch [see Abstract 400 (1913)], describes an arrangement consisting of two similar photoelectric cells connected to an electrometer, both illuminated by the same source, but through different optical paths. The arrangement described has the advantage of being independent of fluctuations in the source (provided that these are uniform over the area of the source), since the electrometer reading depends only upon the ratio of the intensities falling on the two cells. However, it remained impossible to use arcs or other light resources, which not only fluctuate in intensity, but also flicker or change their position; for since the two beams come from different parts of the source and traverse different optical paths, flickering changes the ratio of their intensities, as well as the absolute values. It is the purpose of this note to point out that in most cases the optical paths to the two cells may be made practically identical by using a partially reflecting plane mirror to divide the beam. It is thus shown to be possible to use arcs and similar light sources giving high intensity in all regions of the spectrum for a large number of problems involving photoelectric photometry. A. E. G.

**2084.** *Correction for Width of Slits in Measurements with the König-Martens Spectrophotometer.* **F. Hoffmann.** (Zeits. f. Physik, 37. 1–2. pp. 60–71, 1926. From the Reichsanstalt.)—The "colour temperature" of the comparison lamp is the essential factor required in making this correction, and suitable methods are indicated for determining it. A table of corrections for three widths of slit, in three colours, in the temperature range 1000 to 2000° C. and for a given colour temperature of the comparison lamp has been prepared; it is shown how from this table the values for other widths, colours and temperatures can be derived. The advantage of correcting every individual observation to zero slit width is that the brightness of the field of view can then be adapted to the existing circumstances. For example, in measuring the relation between two brightnesses the slit width can be made larger for the smaller brightness without diminishing the accuracy of the relative measurement. H. N. A.

**2085.** *Photoluminescence of Benzol and Some Derivatives in Different States of Aggregation and Solution.* **A. Reimann.** (Ann. d. Physik, 80. 1. pp. 43–70, May 18, 1926.)—At pressures of the order of 1 mm. benzol vapour emits a fluorescence spectrum consisting of a few lines or bands related to the exciting light. With increased pressure this spectrum passes over at a certain pressure into an upper half through the entry of a new series of bands. This new part does not depend on the nature of the exciting light, and is explained as being due to "impulses of the second kind." In solution with alcohol and as a pure liquid, benzol emits a number of wider bands which correspond to the vapour bands with a shift towards smaller frequencies. This shift increases with increasing concentrations, and in very concentrated solutions the bands were weak and diffuse. If pure benzol is brought to crystallisation without lowering the temperature, the fluorescence increases many times and the bands become as sharp as in dilute alcoholic solution. Solid benzol shows marked phosphorescence. A few simpler derivations such as xylol and cresol, which show scarcely any fluorescence in the fluid state, give, like benzol, strong fluorescence in the crystalline state. At the temperature of liquid air the wide bands emitted at 0° by solid benzene break up into a large number of small bands. This spectrum shows great similarity with that of the vapour. Similarly with *p*-xylol and naphthalene. J. E.

**2086.** *Black-body Brightness at the Platinum and Palladium Points.* **E. Brodhun** and **F. Hoffmann.** (Zeits. f. Physik, 37. 1–2. pp. 137–154, 1926. From the Reichsanstalt.)—Describes the results of measurements of the total brightness of a black-body, found to be 15·66 HK/cm.$^2$ at the Pd point (1557°) and 65·24 HK/cm.$^2$ at the Pt point (1771°) respectively. The mechanical equivalent of light is found to be $1{\cdot}45 \times 10^{-3}$ watt/hefner lumen. The estimated precision is ± 0·5 %.

J. W. T. W.

**2087.** *Uranium as an Activator.* **E. L. Nichols** and **Mabel K. Slattery.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 449–466, May, 1926.)—Traces of a compound of uranium, when brought by fusion into solid solution in $NaPO_3$, $KPO_3$, borax, NaF, or $CaF_2$, render the substance luminescent under photo- or kathodo-excitation. There is a definite optimum proportion for each solvent which gives the maximum brightness. The spectra of these solid solutions consists of several bands, each of which is made up of numerous overlapping and semi-submerged components, but the spectral structure is distinctly different from that of the uranyl salts. The components may be arranged in two or more sets, the frequency interval between members of a given set being constant or some exact multiple of a constant. The frequency interval (18) is the same for all sets of each spectrum and for the different spectra. At least one set in the spectra of preparations, in which $NaPO_3$, NaF and $CaF_2$ respectively are the solvents, is repeated in position, so that these spectra may be regarded as made up chiefly of the same components and as differing only in the *relative brightness* of the components. The position of the brightest component, which determines what may be called the *main crest* of each spectrum, is shifted towards the violet with increase of the molecular weight of the solvent, so that the colour of luminescence goes over from yellow for NaF into green for $CaF_2$ and $NaPO_3$ and into blue-green for $KPO_3$. The phosphorescence of these preparations is of the vanishing type. They are inert under X-rays, but after exposure to X-rays they become thermo-luminescent. At the temperature of liquid air the spectra of solutions in NaF are resolved and those in $CaF_2$ partially resolved, while those in the other solvents remain unresolved. J. E.

**2088.** *Fluorimetry.—II. The Relation between Fluorescence and Hydrogen-ion Concentration.* **L. J. Desha, R. E. Sherrill** and **L. M.**

**Harrison.** (Am. Chem. Soc., J. 48. pp. 1493–1500, June, 1926.)—A study has been made of the effect of varying the hydrogen-ion concentration upon the intensity of the fluorescence of certain sulphonic acids and of quinine. For each substance studied there is a characteristic range of 0·2 Sorensen ($p$H) units, within which about 75 % of the total change in intensity occurs. The curves obtained show such close agreement with the theoretical dissociation curves of weak electrolytes as to suggest strongly a causal relationship between dissociation and fluorescence. The intensity of fluorescence is affected by the total salt content of the solutions even at equal hydrogen-ion concentrations. Chloride ions inhibit the fluorescence of the sulphonic acids studied as well as that of quinine. J. E.

**2089.** *Spectroscopy of the Extreme Ultra-violet.* **T. Lyman.** (Frank. Inst., J. 201. pp. 553–562, May, 1926.)—Gives a *résumé* of the leading results of the work done in this department during the past four years. A. D.

**2090.** *A Graphical Method for the Discovery and Demonstration of Spectral Regularities.* **E. Madelung.** (Zeits. f. Physik, 37. 4–5. pp. 374–375, 1926.)—The wave numbers ($\nu$) are plotted as abscissæ against $1/n^2$ (principal quantum numbers) as ordinates. The points lie—for a given series on a more or less slightly broken curve—on a straight line for hydrogen-like series. The end term (series limit) lies on the intersection of the curve with $n = \infty$. The slope of the tangent at this point is proportional to the Rydberg constants for arc lines; for the spark lines it is proportional to the fourth and ninth powers. A diagram obtained from the Hg arc spectrum is given as an example. It is suggested as useful for finding regularities. J. E.

**2091.** *Depolarisation of Resonance Radiation by Weak Magnetic Fields.* **V. v. Keussler.** (Phys. Zeits. 27. pp. 313–316, May 15, 1926.)—This has been shown (literature cited) to be equally explicable on the classic or the quantum theory except at one point, the case where the magnetic field is at right angles to the electric vector and parallel to the direction of observation. The author has revised this case with the aid of photoelectric methods and finds agreement. A. D.

**2092.** *Occurrence of Harmonics in Spectral Lines.* **H. Nagaoka** and **T. Futagami.** (Imp. Acad. Tokyo, Proc. 2. pp. 153–155, April, 1926. In English.)—Examination of the spectra of several elements indicates the presence of octaves. For $H_2$ the number of octaves in the visible region is small compared with those in the ultra-violet, but good coincidence is obtained. With Hg there are a good many lines falling in groups of octaves, especially among the lines observed by Block with the electrodeless discharge. Cu and Zn show the same characteristics. Similar relations are found for other elements, but more observations of their spectra in the ultra-violet region are needed. R. S. R.

**2093.** *Spectra of Metals excited by High Tension and Heavy Current.* **H. Nagaoka, T. Futagami** and **H. Obata.** (Imp. Acad. Tokyo, Proc. 2. pp. 161–162, April, 1926. In English.)—A condenser of about 1·7 microfarad, charged to 20 kv., is discharged through an inductance coil and spark-gap. The latter consists of the material to be examined placed in a cup of purified carbon with a pointed rod making loose contact. The heavy current causes the material quickly to vaporise, and the spectrum to λ2000 is at once obtained. The advantages are the short time of exposure and the minute quantity of material required. F. S.

**2094.** *Explosion Spectra of Hg, Cu, Fe, etc.* **T. Hori.** (Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No. 53. pp. 59–78, Feb., 1926. In English.)—A condenser of 0·3 m.f. capacity was charged from a transformer, and automatically shorted through an adjustable spark-gap and a fine filament of the metal. It was found that the continuous background required for reversals was satisfactorily produced by the explosion of mercury in a confined space at atmospheric pressure as well as under reduced pressure. Many absorption lines were obtained for Cu, Hg and Fe upon this mercury background. For Cu and Fe the reversal was complete. The lines are tabulated in order of reversal, varying the voltage. As a substitute for the mercury, asbestos fibre soaked in paraffin is also employed, the C produced giving the continuous background. Sharp and diffuse lines of Na, Li, Ag; lines of Ca, Sr, Mg, Cd, Zn, etc; bands of Al, MgO, $CaCl_2$, $CaF_2$, and the Swan and Cyanogen bands were all reversed. A. C. M.

**2095.** *Critical Potentials and Spectra of Oxygen.* **L. L. Lockrow.** (Astrophys. J. 63. pp. 205–217, May, 1926.)—The OI and OII line-spectra and the band-spectra of oxygen in the visible and ultra-violet regions as excited in a low-voltage arc discharge-tube were obtained and the critical potentials for excitation noted. Ionisation of the molecule was found to occur at 16·1 volts. The resonance potential at 9 volts formerly assigned to the atom is also a radiating potential for the molecule. Dissociation of the molecule and simultaneous ionisation of one atom occurs at 19·5 volts. From this value and that for ionisation of the atom, 13·5, the value of 6 volts is obtained for the dissociation potential of the oxygen molecule. This corresponds to an energy of dissociation of 138,000 calories per gramme molecule. Doubly ionised atoms first appear in the discharge at about 50 volts. Energy-levels for the electronic states were observed at 16·1, 19·2 and 21 volts. To these we may add the level at 9 volts as that for the neutral molecule. AUTHOR.

**2096.** *Spectrum of Ionised Oxygen (OII).* **R. H. Fowler and D. R. Hartree.** (Roy. Soc., Proc. 111. pp. 83–94, May 1, 1926.)—This paper contains a correlation of the terms of this spectrum deduced by A. Fowler [see Abstract 1334 (1926)] with those expected from the theory of Heisenberg and Hund. Some identifications cannot be made with certainty, but the general agreement of theory and observation is good. No lines involving the deepest-lying terms have yet been identified, but it appears likely that the normal term of the OII spectrum is a quartet S term. F. S.

**2097.** *Quartet Terms in the Copper Arc Spectrum.* **C. S. Beals.** (Roy. Soc., Proc. 111. pp. 168–181, May 1, 1926.)—Photographs of the copper arc spectrum have been taken in the range 2000–6700 Å, with both a quartz spectograph and also a concave grating. Zeeman-effects have been photographed in the higher orders of the grating. Wave-lengths, intensities, Zeeman patterns, and term combinations are tabulated. The magnetic resolutions have led to the identification of a number of quartet terms. Combinations between these give rise to a number of multiplets, and some combinations occur between quartets and previously determined doublet levels. This is the first instance of an element in group one of the periodic table, being shown to have a spectrum containing terms of greater multiplicity than two, and raises the question as to whether previous views of the structure of the copper atom are correct. F. S.

**2098.** *Arc Spectrum of Copper.* **C. G. Bedreag.** (Comptes Rendus, 182. pp. 1209–1211, May 17, 1926.)—The numerous lines constituting the arc spectrum of copper can be divided into three groups: (*a*) The Rydberg doublets $s-p$, $p-s$, $p-d$, $d-f$, arising from the electron arrangement (2. 8. 18). 1, *i.e.* from a stable configuration of 28 electrons plus 1 spectral electron; (*b*) the lines belonging to a second complex spectrum, made up of the complex doublets $p-p'$, $d-d'$, $p_1-d_1$, and of quartets arising from a second electron arrangement (2. 8. 17). 2; (*c*) the combination lines obtained from the terms of groups (*a*) and (*b*). In view of the theoretic interest presented by the arc spectrum of copper, the author has undertaken the division of the lines into the above three groups. For group (*a*) a table is given of terms $T = N_{kj}$, where *n* represents, on Bohr's theory, the principal quantic number of the orbit described by the spectral electron; *k* represents the second quantic number (azimuthal), $k = 1, 2, 3, 4$ and determines the quality of the terms *s*, *p*, *d*, *f*; the indices *j* represent the third quantic number (interior), and take the values 1 and 2 for *p*, 2 and 3 for *d*, 3 and 4 for *f*. A table is given of 23 lines defined by the terms of the first table. Five of these are new lines. The difference between the observed and calculated values of the wave numbers of these lines lies between $\pm 1$ and $\pm 2$. It also has been found that the lines $p-f$, $p-p$ with $\Delta k = 2$ or 0, which are not observed under ordinary conditions, appear or are reinforced in the arc at 200 volts, *i.e.* in an intense electric field and consequently at the commencement of the Stark-effect. Under these conditions other new lines also appear. A. W.

**2099.** *Quartet and Doublet Terms in the Copper Spectrum.* **A. G. Shenstone.** (Science, 63. pp. 641–642, June 25, 1926.)—The lowest term of the spark-spectrum which arises from ten *d*-electrons should be $a^1S$, and the addition of one electron should give a doublet spectrum. This spectrum is known. The next higher terms arise from nine *d*-electrons and one *s*-electron. The quartet terms corresponding to this are given, and it is stated that a set of thirty-five negative terms has been found from combinations of low quartet and doublet terms, which accounts for about three hundred lines above λ2900. A detailed discussion of the spectrum is to be published. F. S.

**2100.** *Spectra of N from Compounds.* **H. O. Kneser.** (Ann. d. Physik, 79. 7. pp. 585–596, April 23, 1926.)—The spark discharge was maintained in a stream of gas. $N_2$, $N_2O$, NO, $NO_2$, $NH_3$ all gave a streaming effect, *i.e.* different spectra in different parts of the positive column. Intensities in the several band groups of nitrogen in the different spectra were compared, and conclusions made as to the particles responsible. The third positive bands and the negative groups were not seen in the ammonia spectrum. Water-vapour and $Cl_2$ also showed a streaming effect. A. C. M.

**2101.** *Excitation of Nitrogen Bands by Electronic Impact.* **H. O. Kneser.** (Ann. d. Physik, 79. 7. pp. 597–609, April 23, 1926.)—Electrons were accelerated in a tube and the accelerating voltages measured at which band-heads appeared. The strongest bands of the first positive group appeared at 10·9 volts, the null bands of the second positive group at 14·8 volts, and the null bands of the negative group at 19·5 volts, all ± 0·4 volt. A suggestion is made for the origin of the first positive group. An estimate is made of the intensities of the bands in the visible. Increase in the intensity goes with decrease in the oscillation quantum number ($n$) in the second positive bands and even more markedly in the negative groups. A. C. M.

**2102.** *The Helium Spark Line* 4686. **P. Kunze.** (Ann. d. Physik, 79. 7. pp. 610–636, April 23, 1926.)—The fine-structure of λ4686 was examined with (*a*) a Hilger echelon of 33-cm. path in glass; (*b*) a Goerz echelon of 49·5-cm. path in glass; (*c*) a Hilger Lummer-Gehrcke plate 4·2 mm. thick; (*d*) a Goerz Lummer-Gehrcke plate 1·1 mm. thick. The line was produced by a discharge in helium produced in four ways: (1) Tube with hollow kathode and condensed discharge; (2) electronic impact in a tube with field; (3) tube with hollow kathode and direct current; (4) electronic impact in a tube with a field-free space. Thus sixteen combinations were possible, but only five gave measurements, owing to small dispersion and the small separation of the orders. The Lummer-Gehrcke plate only showed a doublet, while with the echelons the triplet separations were measureable. The line given by Paschen as $III_{ab}$ is shown to be a "foreign" line, and also another foreign line probably coincides with $I_{ab}$. The most promising method for avoiding foreign lines is declared to be the electronic impact method. A. C. M.

**2103.** *Spectra of* $Rb^+$ *and Kr.* **O. Otsuka.** (Zeits. f. Physik, 36. 9–10. pp. 786–794, 1926.)—Measurements were made of the spark-spectrum of rubidium between λ2559 and λ3596, and of the first krypton spectrum between λ3665 and λ8113. In both cases the photographs were taken in the first order spectrum of a 6·4-metre grating, the dispersion amounting to 2·62 Å.-E/mm. In the case of rubidium the electrodeless ring discharge used by Dunoyer was employed. In the region λ3596–3195 the results agree with the work of Reinheimmer [Abstract 2416 (1923)] on Rb. Owing to impurities in the krypton the photographs show the groups λ3883 and λ4216 of the cyanogen band. The frequently observed variations of the intensity distribution in these bands are well brought out in photographs included in the paper. W. S. S.

**2104.** *Electronic and Band-spectrum Structure in Diatomic Molecules. III. Molecule Formation and Molecular Structure.* **R. S. Mulliken.** (Nat. Acad. Sci., Proc. 12. pp. 338–343, May, 1926.)—A continuation of previous work [see Abstract 1821 (1926)]. The normal states of a number of molecules are given together with those of the constituent atoms. It is supposed that when atoms approach sufficiently near to each other, the rules of Pauli and Hund apply to the outer electrons, even though these remain attached to the parent nuclei. There is also evidence in some cases of penetration of the electron orbits. A number of molecular spectra are discussed from this point of view. F. S.

**2105.** *The Absorption Spectra of the Vapours of Zn, Cd, Pb, Sn, Bi and Sb.* **J. G. Frayne** and **A. W. Smith.** (Phil. Mag. 1. pp. 732–737, April, 1926.)—The absorption spectra of these metals at temperatures up to 1150° C. have been investigated, the metals being vaporised in an open-ended graphite tube of the form described by Zumstein [Abstract 1378 (1925)]. J. S. G. T.

**2106.** *Critical Potentials and the Heat of Dissociation of Hydrogen as determined from its Ultra-violet Band-spectrum.* **E. E. Witmer.** (Nat. Acad. Sci., Proc. 12. pp. 238–244, April, 1926.)—Lyman has found that under certain conditions of excitation hydrogen mixed with a large excess of argon gives a series of eleven groups of lines between λ1063 and 1670. Taking $e_t$ as the total electronic quantum number for the hydrogen molecule, and $n$ and $m$ as the vibrational and nuclear rotational quantum numbers respectively, then the groups observed are attributed to the transitions $(e_t' = 2, n' = 0)$ to $(e_t'' = 1, n'' = 0$ to $11)$. If E is the vibrational energy in the normal level $(e_t = 1)$, then $dE/dn''$ is a measure of the vibrational frequency. By plotting the curve $\left(n'', \frac{1}{h}\cdot\frac{\Delta E}{\Delta n''}\right)$ for these bands the vibrational frequency is found to become zero shortly beyond $n'' = 11$. The heat of dissociation D, taken as the vibrational energy for that value of $n''$ at which the frequency vanishes, comes out to be 100,100 calories, a value in agreement with Isnardi's result. Reasons are advanced for supposing it possible to assign total electronic quantum numbers to the orbits in the hydrogen molecule, in such a way that the difference in energy of the orbits of total quantum numbers $e_t$ and $e_t''$ will be nearly the same as the difference in energy of the orbits of the same total quantum numbers in the hydrogen atom, although the actual energies of corresponding orbits will differ. The present bands show that the lowest resonance potential of the hydrogen molecule is 11·61 volts, and this must represent the transition $e_t = 2$ to $e_t = 1$. The bands given by the hydrogen molecule in the visible region will be due to the transitions $e_t'' > 3$ to $e' = 2$. Glitscher has identified in the visible band-spectrum a series of peak frequencies corresponding to the $\alpha$, $\beta$, $\gamma$ and $\delta$ lines of the Balmer series. By the principle stated above, the higher resonance potentials of the hydrogen molecule should be given by adding the voltages appropriate to these peak frequencies to 11·61 volts. The ionisation potential will then be obtained by extrapolation. This is done, and a probable value for the ionisation potential comes out to be 15·19 volts. The divergence of this value from that given by electron impact experiments is attributed to the fact that in the latter an impacting electron has always to supply, in addition to the energy for the electronic transition it produces, a certain amount of vibrational energy. The observed critical potentials would thereby be increased, as a comparison with the spectroscopic data indicates. W. S. S.

**2107.** *Intensities and Reflecting Powers in the Lyman Region of the Hydrogen Spectrum.* **A. H. Pfund.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 467–472, May, 1926.)—The intensity of the Lyman series in the hydrogen spectrum is compared with that of the spectrum as a whole. A discharge tube 120 cm. long communicates with a bell jar containing a thermocouple, and the gas in the tube is subjected to an e.m.f. of 7500 volts at a pressure of 0·08 mm. The tube is end-on to the measuring apparatus, and the radiation is directed on the thermocouple by concave glass reflectors so that the thermocouple is unaffected by ions; the secondary spectrum is also eliminated. The effect of cutting out the Lyman series by means of a glass, fluorite, or thin nitrocellulose screen is observed, and it is thus found that 90 % of the energy of the spectrum resides in the series in question. The reflecting power for the series of several substances has been measured, that of crown glass being 8·5 %, while the highest is that of quartz, *viz.* 13·5 %. C. W. H.

**2108.** *Intensity of the Forbidden Mercury Line* (λ2270). **T. Takamine.** (Zeits. f. Physik, 37. 1–2. pp. 72–79, 1926.)—The appearance in the mercury spectrum, under certain conditions of excitation, of the line λ2270 which corresponds to the transition $2p_1 - 1S$ (Paschen-Götze notation), and which is forbidden by the selection principle, has previously been noted by the author. In the present measurements the positive column in a specially constructed tube of transparent silica was used as source, and the intensities of a number of mercury lines, including the forbidden one, were determined for current densities in the tube ranging from 0·06 to 1·50 amps./cm.$^2$. Photographs were taken for both the transverse and end-on aspects of the tube. The data from the former were easier to interpret, as the complication of self-reversal was here largely avoided. In marked contrast to the remaining lines, the intensities of which steadily increased with current density, it was found that the intensity of the forbidden line for current densities below 0·25 amps./cm.$^2$ rapidly increased with current density, reached a maximum for the density quoted and then fell off gradually. It was noted that a diffuse band at λ2345 always appeared with the forbidden line, and that its intensity variations ran parallel with those of the latter. The appearance of this band is often ascribed to a HgH molecule, and it is suggested that the excitation of the forbidden line is related to the formation of such molecules. A tentative explanation of the intensity variations of the forbidden line is advanced, assuming that at high current densities the number of impacts between electrons and atoms increases and that these impacts may bring about so-called Inter-$p$-transitions from $2p_1$ to $2p_2$. Among the lines observed was one at λ2262, which has not up to now been included in the arc spectrum. This line is a spark-spectrum line, but as other spark-spectrum lines do not appear it is concluded that this line requires only a little higher voltage than the ordinary arc lines. The intensity variations of this line differed somewhat from those of the arc lines. W. S. S.

**2109.** *L-Emission Series of Mercury.* **C. E. Eddy** and **A. H. Turner.** (Roy. Soc., Proc. 111. pp. 117–124, May 1, 1926.)—The L-emission lines of most of the heavy elements from ytterbium to uranium have been investigated by Coster [see Abstract 1997 (1921)] and by Dauvillier [see Abstract 17 (1923)], but their tabulated results do not include data for some radio-active elements and mercury. Müller [Abstract 565 (1922), by means of a tube of the "gas-filled" type and a liquid mercury target, overcame the inherent difficulty regarding mercury, *viz.* that of the rapid volatilisation of the mercury from the face of the anti-kathode. The author of this paper has found it possible to prepare targets amalgamated with mercury which are sufficiently lasting to enable their use in a tube of the hot-filament type; by these means measurements of the wave-lengths of the emission lines have been made with an accuracy exceeding that of Müller. In addition, several new lines have been measured, and an attempt has been made to clear up a certain amount of confusion which exists regarding the designation of some of the L spectra of elements of higher atomic number. **A. B. W.**

**2110.** *Fine Structure and Zeeman-Effect of Complex Mercury Lines.* **A. E. Ruark.** (Phil. Mag. 1. pp. 977–995, May, 1926.)—This is a continuation of previous work [see Abstract **524** (1926)] on the fine structure of spectral lines of non-hydrogenic atoms. The existing observations of the Zeeman-effect of complex lines of mercury, cadmium and thallium are considered, and it is concluded that they do not suffice to yield general rules for the production of Zeeman patterns from a knowledge of the quantum numbers of a given level. **F. S.**

**2111.** *K-Spectrum of Carbon.* **A. Dauvillier.** (Comptes Rendus, 182. pp. 1083–1085, May 3, 1926.)—A vacuum X-ray spectrograph was used in conjunction with a small tube of pyrex glass. As crystal a film of melissic acid on lead was used and a target of graphite was used in the tube. In order to avoid fogging by light, the Schumann plate was protected by a film of magnesium coated on celluloid $10^{-5}$ cm. thick from a wire heated *in vacuo.* This transmits blue light feebly, but 30 % of carbon K-radiation. A strong but diffuse line was obtained at 45·3 Å., identified as $K\alpha_2$ line of carbon, and also a faint background as far as 70 Å. **F. S.**

**2112.** *Remarks on the Relation between Duane's Quantum Theory of Interference and the Broglie Wave Theory.* **P. Jordan.** (Zeits. f. Physik, 37. 4–5. pp. 376–382, 1926.)—The quantum theory of grating interference of Duane [see Abstract **2430** (1923)] lends definitely to the result that a material particle has certain physical properties which obtain a clear meaning through the use of the de Broglie "waves." Entirely mathematical, making use of the results of Born, Heisenberg and Jordan and of Dirac. **J. E.**

**2113.** *The Production of Fluorescence in the X-Ray Region.* **P. Auger.** (Comptes Rendus, 182. pp. 1215–1216, May 17, 1926.)—The author has shown previously [Abstract **1358** (1926)], by use of the Wilson condensation method, how to evaluate the production of excited atoms by X-rays from the photoelectric effect. The data then recorded referred to the K-levels of argon and krypton, and the present paper now extends the measurements to xenon ionised for the levels K and L. The experimental arrangements are described. A considerable variation is found for the atomic number of the element studied as well as difference of excited level, and the author concludes from a consideration of the same level for different elements, or successive levels for the same element, that the production of fluorescence increases with the frequency of the corresponding radiation. **H. H. Ho.**

**2114.** *Ratio of the Modified to the Total Scattering Coefficient of X-Rays.* **O. K. DeFoe.** (Phys. Rev. 27. pp. 675–686, June, 1926.)—Use has been made of the fact that the modified portion of scattered X-rays has not only a greater wave-length, but also a greater absorption coefficient than the primary X-rays in order to separate the modified and unmodified portions of a scattered X-ray beam. The method involves the change in the intensity of scattered X-rays when a given thickness of aluminium is transferred from the primary to the scattered beam. Using a balance method, measurements of the ratio of the modified to the total scattering coefficient have been made for X-rays of wave-lengths 0·27 Å. to 0·58 Å., scattered from carbon, aluminium and copper at angles varying from 60° to 130°. Jauncey's theory predicts that the ratio should become unity when vers $\phi = 242\lambda_0^2/\lambda_s$ ($\lambda_s$ and $\lambda_0$ being measured in Ångstroms). For carbon at 60° and 90° the experimental ratio becomes unity at wave-lengths of 0·32 Å. and 0·46 Å. respectively. The theory gives 0·31 Å. and 0·44 Å. A calculation of the modified scattering coefficient for copper at 90° for $\lambda = 0{\cdot}4$ Å. gives $0{\cdot}71s_0$ (where $s_0$ is the Thomson coefficient at 90°), while the theory gives $0{\cdot}74s_0$. Thus as far as they go the experiments are in agreement with the theory. **Author.**

**2115.** *Quantum Theory of the Unmodified Line in the Compton-Effect.* **G. E. M. Jauncey.** (Phys. Rev. 27. pp. 687–690, June, 1926.)—According to the theory developed in two previous papers [see Abstracts 1670 and 2100 (1925)] it is shown that the unmodified line should disappear at a scattering angle $\phi$ given by vers $\phi = (3 + 2\sqrt{2})(\lambda_0^2/\lambda_s)(mc/h)$, where $\lambda_0$ is the wave-length of the primary X-rays and $\lambda_s$ the K critical absorption wave-length of the scattering substance. This formula shows that there is an unmodified line for all values of $\phi$ when Mo K$\alpha$ rays are scattered by carbon and heavier elements, but when scattered by boron and lithium this line should disappear at 147° and 60° respectively. The theory of the previous papers gives the ratio of the number of electrons in orbital positions U such as to scatter unmodified rays in a direction $\phi$ to the number of electrons in orbital positions M such as to scatter modified rays. A formula for the ratio of the probability of an electron scattering when in the U position to that when in the M position is given, together with a simpler method for calculating the number of electrons in the M position to the number in the U and M positions for elliptic orbits. **Author.**

**2116.** *Intensity of Reflection of X-Rays by Crystals.* **W. L. Bragg, C. G. Darwin** and **R. W. James.** (Phil. Mag. 1. pp. 897–922, May, 1926.)—The paper is a general review of formulæ that describe the intensity of the reflection of X-rays from crystals. Two formulæ have been used, one applicable to perfect crystals, the other to a mosaic of small fragments. The main object is to determine the scattering of radiation by the atom, and it is necessary to know which formula is applicable. Numerical comparison shows that rock-salt, fluorspar, and barytes approximate closely to the imperfect type, while calcite is intermediate. Various corrections are discussed which must be applied to crystals of intermediate character. **Authors.**

**2117.** *Reflection of X-Rays from Crystals.* **R. Schlapp.** (Phil. Mag. 1. pp. 1009–1025, May, 1926.)—A mathematical investigation of the X-ray optics of perfect crystals on the basis of the electromagnetic theory of light in continuous media. Solutions are obtained of the equations of propagation of electromagnetic waves in a medium whose S.I.C. is a periodic function of position. The results reproduce most of the features of propagation and reflection of X-rays in crystals. It is thus found that the simplest form of propagation in an unlimited stratified medium consists of a sheaf of plane waves travelling forwards and backwards along a discrete series of directions. One of these waves, corresponding to the predominant term in the solution and the predominant amplitude, travels with approximately the speed of light. The amplitudes of the subsidiary terms fall off as their direction deviates more from that of the predominant wave. For certain directions the disturbance is effected with an exponential damping factor. This damping factor represents the effect of partial reflections from the successive strata in robbing the primary beam and enhancing the reflected beam. Darwin's primary extinction is thus represented in this solution by this exponential damping factor. In considering a crystal as a stratified medium of infinite depth bounded by a face parallel to the plane $y = 0$, it is shown that waves polarised in the plane of incidence will only be appreciably reflected within a very narrow range of glancing angle. The range of perfect reflection is from 0 to arc $\sin\sqrt{1 - K_0}$ and ranges of width $\frac{\psi_2\lambda}{2nd\cos\phi}$ symmetrical about positions $\phi$ given by $\sin^2\phi = 1 - K_0 + n^2\left(\frac{pd}{\pi c}\right)^2$, where $K_0$ is the mean S.I.C., $\psi_2$ and $p$ are constants, $n$ is any integer, and $d$ is distance between stratifications. The value of $\phi$ given above differs slightly from that given by Bragg's relation, which is $\phi_0 = \text{arc}\sin n\frac{\pi c}{pd}$. Denoting $1 - K_0$ by $2t$, it is found that $\phi - \phi_0 = t\sec\phi\,\text{cosec}\,\phi$, which is the relation found by Darwin [see Abstract 1262 (1914)] on the assumption that the Bragg formula holds accurately, but that owing to a refractive index $1 - t$ corresponding to a beam S.I.C. of $1 - 2t$ the angle $\phi$ of incidence on the face of the medium is not the same as inside. Calculation shows that the region of perfect reflection contributes to the area under the intensity-angle curve three-quarters of the whole. Numerical calculation shows that the breadth of perfect reflection in the first order of Pt $K\beta$ radiation from rock-salt is about 3·7 sec. of arc and that the radiation is damped to $1/e$ after traversing about 6000 atomic planes. The factor $\frac{1}{2}(1 + |\cos\phi|)$ is obtained for the effect of unpolarised radiation as compared with polarised, and for the structure factor $(Z^2 + Z_1^2 + 2ZZ\cos 2r\delta)^{\frac{1}{2}}$ is used. A temperature factor is also deduced on the assumption that the departure of atoms from the median planes as a result of temperature oscillations follow the usual distribution law. This factor is $e^{-\frac{2KT}{\sigma}\cdot\frac{n^2\pi^2}{d^2}}$, where K is Boltzmann's constant. Finally the author points out that the factors here obtained, representing the effects of polarisation, structure and temperature, are the square roots of values obtained by a simpler theory in which each plane is supposed to scatter independently. This result is in accord with Darwin's later results and with Ewald's experimental results.

J. E.

**2118.** *Refraction of X-Rays in Prisms of Various Materials.* **C. M. Slack.** (Phys. Rev. 27. pp. 691–695, June, 1926.)—The method consisted in the use of the "double X-ray spectrometer" for measuring the extremely small changes in the angle produced by refraction in prisms which were placed between two crystals. The rocking curves from the second crystal were from 6 to 10 sec. of arc wide at half-maximum and, under favourable temperature conditions, a shift of 0·2 sec. could be detected. Two different wave-lengths of X-rays and prisms of various materials were used. The values of $\delta \times 10^6$, where $\delta = 1 - \mu$, are as follows :—

| λ. | Silver. | Copper. | Sulphur. | Aluminium. | Carbon. | Celluloid. | Paraffin. |
|---|---|---|---|---|---|---|---|
| 0·7078 Å. | 5·85 ± 0·3 | 5·95 ± 0·5 | 1·39 ± 0·05 | 1·68 ± 0·07 | 1·23 ± 0·15 | 0·980 ± 0·03 | 0·701 ± 0·03 |
| 1·537 Å. | | | | 8·40 ± 0·2 | | 4·78 ± 0·1 | 3·28 ± 0·15 |

These results agree with the Lorentz dispersion formula within experimental error. In the case of certain materials, notably graphite, the curves from the second crystal were extremely broad (20 to 50 sec.), caused by internal refraction due to the granular structure. This seems of interest with respect to the possibility of comparing internal arrangements of particles in various samples, though nothing of that sort was attempted. AUTHOR.

**2119.** *Origin of K-Radiation from the Target of an X-Ray Tube.* **M. Balderston.** (Phys. Rev. 27. pp. 696–708, June, 1926.)—The fluorescent energy transformation coefficient, the ratio of the energy of secondary K-radiation emitted by an elementary volume of the radiator to the energy absorbed by it from the exciting X-rays, is observed for Fe, Ni, Cu, Zn, Mo, and Ag. The ratio of quanta emitted as K-radiation to quanta absorbed seems to be a constant for a given metal: Fe — 33 % ; Ni — 39 % ; Cu — 43·5 % ; Zn — 50 % ; Mo — 83 % ; Ag — 75 %. Making use of the experimentally determined values of the transformation coefficient, the fluorescent K-characteristic radiation from the target of an X-ray tube is calculated for Cu and Ag, and compared with observed values of the total K-radiation. An estimate is also made from theoretical considerations of the relative amounts of direct impact K-characteristic radiation to be expected from an X-ray tube target. The calculations indicate that for silver and probably for other elements of high atomic number practically all of the K-characteristic radiation from an X-ray tube is fluorescent in origin, while for copper and probably other elements of low atomic number a considerable part of the K-radiation is due to direct impact of the kathode electrons. AUTHOR.

**2120.** *Dispersion of Gipsum for X-Rays.* **E. Hjalmar.** (Ann. d. Physik, 79. 6. pp. 550–556, April 6, 1926.)—In a previous paper the writer and Siegbahn obtained the dispersion curve for gipsum by measurements of the ratio $d_K/d_g$ (the lattice constants of calc spar and gipsum for different wave-lengths). This curve showed anomalous dispersion at the Ca and S absorption limits. The present method is a direct one based on that of Stenström for the determination of refractive indices. This consists essentially of comparing the measurements of reflection for different orders with the calculated values on the simple Bragg relation. The curve $\delta/\lambda^2$ is plotted against wave-length, where $\delta = \dfrac{\sin\phi_1 - \sin\phi_n/n}{1/\sin\phi_1 - 1/n\sin\phi_n}$, and $n$ is the order. This curve shows the same features as the abovementioned one, and follows the same course. J. E.

**2121.** *Scattering Powers of Calcium and Fluorine for X-Rays.* **R. W. James and J. T. Randall.** (Phil. Mag. 1. pp. 1202–1214, May, 1926.)—In this investigation the absolute intensities of reflection have been measured for a series of spectra from fluorite. The structure-amplitudes in the crystal are of three types, Ca + 2F, Ca, and Ca − 2F, and the observed spectra are grouped on three corresponding curves. The spectra of type Ca − 2F are absent or very small for small glancing angles, but became much more important relatively to those of type Ca and Ca + 2F at larger glancing angles. This shows in a direct way that the value of the scattering power F for fluorine becomes less and less important relatively to that for calcium at large angles of scattering. Curves showing the variation of the square root of the integrated reflections for the three types of spectra are given. From these curves it is possible to calculate the curve for fluorine in three different ways. The curves so obtained are divergent for small glancing angles, but agree at higher ones. The divergence is ascribed to increased absorption due to "extinction." On the assumption that the extinction is proportional to the observed intensity, a correction is applied which removes most of the difference between the three curves. The F curves for fluorine and calcium are obtained from the observations, and are compared with those calculated by Hartree. The Ca curve falls away much more rapidly than Hartree's curve for moderate angles, and it is unlikely that the temperature factor will account for all the difference. H. H. Ho.

**2122.** *Nature of Soft X-Rays.* **A. Dauvillier.** (Comptes Rendus, 182. pp. 927–929, April 12, 1926.)—Deals with experiments bearing on the work of F. Holweck [Abstract 1593 (1926)]. It is concluded that the source of the rays was as much the celluloid window as the tungsten antikathode, that the anomaly observed at 280 volts corresponds to the emission of the K-rays of carbon, that the solid light elements at least emit intense characteristic rays when they are bombarded with electrons, and that the soft X-rays so far studied are chiefly the L- and K-rays of C, N and O of celluloid. W. H. Ge.

**2123.** *The β-Rays associated with Scattered X-Rays.* **J. M. Nuttall and E. J. Williams.** (Phil. Mag. 1. pp. 1217–1235, June, 1926.)—The short β-ray tracks produced by homogeneous X-rays of different wavelengths in oxygen, nitrogen, argon and hydrogen have been investigated by the Wilson cloud method. The distribution of the short tracks in O and N was found to be a random one, at least when the origins are more than 1 mm. from those of the long tracks. According to the theory which regards the short tracks as being caused by recoil electrons associated with the scattering of the X-rays, while the long ones are due to electrons ejected with initial kinetic energy comparable to a quantum of the incident radiation, the ratio $N_R/N_P$ of the number of short to the number of long tracks should be equal to the ratio of the scattering coefficient to the absorption coefficient multiplied by the fraction $f$ of scattered quanta which cause electrons to leave their atoms; $f$ has been calculated on certain assumptions, and the theoretical values of $N_R/N_P$ agree satisfactorily with the observed values. The agreement strongly supports the quantum theory of scattering. H. N. A.

## RADIO-ACTIVITY.

**2124.** *Period of Decay of RaB and RaC.* **P. Bracelin.** (Cambridge Phil. Soc., Proc. 23. pp. 150–154, April, 1926.)—A galvanometer, with a suitable range of shunts, is applied to the measurement of ionisation currents (produced by α-rays from pure RaC) between two parallel plates. From the results a transformation constant

$$\lambda = (3 \cdot 514 \pm 0 \cdot 007) \times 10^{-2} \text{ min.}^{-1}$$

has been assigned to RaC, corresponding to a half-valve period of 19·72 ± 0·04 min. Similar measurements with Ra active deposit have enabled a value to be estimated for the period of RaB between 26·7 and 26·8 min., which is the limit of accuracy of the experimental data.
A. B. W.

**2125.** *Decay of RaE.* **L. F. Curtiss.** (Phys. Rev. 27. pp. 672–674, June, 1926.)—The decay of the activity of a preparation of RaE shown to be quite free from RaD has been observed over a period of 45 days. The half-period, determined by the method of least squares, for this sample was 5·07 days. This value agrees with measurements by Antonoff, Meitner and Bastings, but it is in disagreement with the value of 4·85 days determined by Thaller and recently observed by Fournier [see Abstract 316 (1926)]. It appears that the value given by Thaller, and previously accepted, cannot be correct.
Author.

**2126.** *Note on the Hypothetical Emanation of Potassium.* **B. Kracke.** (Phys. Zeits. 27. p. 290, May 1, 1926.)—Calls attention to the negative results of Elster, Geitel and Bergwitz in searching for a potassium emanation. Describes an investigation of a blower of gas in a potassium mine at Ehman, near Fallersleben, which apparently had passed through thick layers of potassium salt. No trace of activity was found on a lead wire about 10 metres long, wound on a frame and charged to − 1700 volts, after it had been placed for an hour in the gas stream. The same was true when the gas was directly passed into the ionisation space of a sensitive electrometer.
H. N. A.

**2127.** *High-frequency Rays of Cosmic Origin. Part I. Sounding Balloon Observations at Extreme Altitudes.* **R. A. Millikan** and **I. S. Bowen.** (Phys. Rev. 27. pp. 353–361, April, 1926.)—Four specially designed instruments, each comprising a recording electroscope, thermometer and barometer and each weighing but 190 gm., were sent up with sounding balloons from Kelly Field, Texas. Three were recovered, and of these two had satisfactory records of their flight, during which they reached altitudes of 11·2 and 15·5 km. respectively. A comparison of the recorded electroscope at the 5-km. level during ascent with the reading at the same level during descent shows that the average discharge rate of the electroscopes while above the 5-km. level was about three times their discharge rates at the surface of the earth, and corresponded to an average rate of production of ions of 46·2 per c.c. per sec. This is only 25 % of the value to be expected from the observations of Hess and of Kolhörster, and constitutes definite proof that there exists no penetrating radiation of cosmic origin having an absorption coefficient as large as 0·57 per metre of water. **V. F. Hess.** (Phys. Zeits. 27. pp. 405-406, June 15, 1926.)—Remarks on the above. [See also Abstract 935 (1926).]
Authors.

**2128.** *High-frequency Rays of Cosmic Origin. Part II. Mountain Peak and Airplane Observations.* **R. A. Millikan** and **R. M. Otis.** (Phys.

Rev. 27. pp. 645–658, June, 1926.)—The elimination in penetrating ray experiments of temperature and pressure effects is accomplished through new features in the design of Wulf electroscopes, but especially through immediate reduction *in situ* of all deflections to volts. When suitable precautions are taken for eliminating the activity of adjacent rocks, both airplane and mountain peak observations agree in showing a definite variation of the penetrating radiation with altitude alone. Within the limits of experimental error all observations are consistent in showing no dependence of the penetrating radiation upon the time of day or upon the position of heavenly bodies. Absorption experiments made on Pike's Peak with lead sheets 4·8 cm. thick furnish evidence for the existence on mountain peaks of copious new rays of local origin of no greater hardness than that of gamma rays. If these new rays are assumed to be homogeneous, their absorption coefficient is about 3·1 per metre of water. These experiments, however, furnish no definite evidence for the existence of very penetrating rays of cosmic origin. Such rays cannot produce as much as 2 ions per c.c. per sec. at sea-level if they have an absorption coefficient not less than 0·25 per metre of water. If cosmic rays exist at all they must be less intense than this, or else they must be more pentrating than anyone has as yet suggested. AUTHORS.

**2129.** *The Scattering Effect of γ-Radiation in Water and the Origin of Penetrating Radiation at Sea-level.* **G. Hoffmann.** (Phys. Zeits. 27. pp. 291–297, May 1, 1926.)—A Wulf two-leaf electrometer has been used to measure the penetration of γ-radiation from radium preparations placed at different depths up to 2 metres in water, and so determine the effect of scattering. Values of the intensity of radiation at different distances in air and water are tabulated. For distances exceeding 1 m. the scattered radiation intensity exceeds by many times that of the direct rays, while the total effect of the scattering is limited to an increase of the ionisation to about 70 %. If these determinations of the Ra content of water are correct, then to explain the high values of radiation intensity in water and at low levels an especially high radiation source is required. It is considered that Hess and Millikan's statement that ionisation by secondary γ-radiation is limited, and that this, originating from the ultra γ-radiation, or height radiation, by the Compton process, appears to give an explanation of the difference of the absorptions of water and lead. The author's absorption measurements in lead cannot be affected by the Ra content of lead, and thus the γ-radiation at sea-level can set free as a maximum a direct effect of 0·1 I. The assumption that an electronic radiation takes place is proved by a preliminary experiment, while the possibility of demonstrating a direction effect by a combination of water and lead absorptions is discussed. [See also Abstract 1130 (1925).]

R. S. R.

# HEAT.

**2130.** *The Quantum Problem in the Theory of Heat.* **A. Eucken.** (Zeits. techn. Physik, 7. 4. pp. 180–187, and 7. 5. pp. 216–223, 1926.)—In this paper the author gives a general review of the chief difficulties arising in the attempt to place the theory of heat on a quantum basis. He takes the results of classical mechanics and shows where they fail to represent the result of experiment and how they may be better explained by grafting on to statistical mechanics the results required by the quantum theory of energy. He starts with the six-dimensional phase space equations of statistical mechanics and shows how they can be modified to contain the necessary quantum relations. He deals especially with a linear oscillator, rotational energy of the molecule, evaporation equilibrium and multiple-component systems (Nernst's theorem). The directions in which further exact experimental work is required in order to test the results of the quantum theory are pointed out. At the end of the paper a very complete list of references to papers dealing with the subject is given. T. B.

**2131.** *Heat Transfer in the Annular Space between Two Coaxial Cylinders.* **S. R. Parsons.** (Phys. Rev. 27. pp. 788–792, June, 1926.)—Two brass tubes are mounted with a common axis, one inside of the other, and are warmed by driving hot air, in turbulent flow, through the annular space between them. The rates of transfer of heat to the two tubes are compared by means of a coefficient representing heat transmitted per unit time per unit area of metal surface per unit difference of temperature between metal and air. Lees has shown that in stream-line flow there would be a difference in the surface friction per unit area for the two tubes, and if that were true in turbulent flow, there would be a corresponding difference in the coefficients of heat transfer. The experimental results show that if there is such a difference in turbulent flow, it is not of the magnitude to be expected from Lees' equations [see Abstract 15 (1916)], and fail to show with certainty that any difference exists. AUTHOR.

**2132.** *Ratio of Heat Losses by Conduction and by Evaporation from any Water Surface.* **I. S. Bowen.** (Phys. Rev. 27. pp. 779–787, June, 1926.)—It is shown that the process of evaporation and diffusion of water-vapour from any water surface into the body of air above it is exactly similar to that of the conduction or "diffusion" of specific heat energy from the water surface into the same body of air. Because of this similarity it is possible to represent the ratio R of the heat loss by conduction to that by evaporation by the formula

$$R = 0\cdot46\left(\frac{T_w - T_a}{P_w - P_a}\right)\frac{P}{760}$$

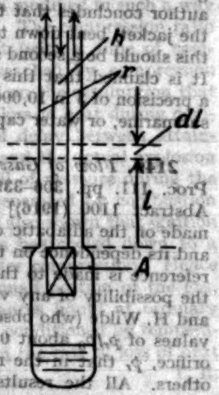
where $T_a$ and $P_a$ are the original temperature and vapour-pressure of the air passing over the lake, and $T_w$ and $P_w$ are the corresponding quantities for the layer of air in contact with the water surface. The substitution of R times the evaporation loss for the value of the conduction heat loss in the Cummings equation for evaporation makes it an exact equation for the determination of evaporation from any water surface in terms of the net radiant energy absorbed by the water and the heat stored in the water. AUTHOR.

**2133.** *Theory of the Specific Heat of Solutions.* **F. Zwicky.** (Phys. Zeits. 27. pp. 271–286, May 1, 1926.)—A discussion is given of the factors which control specific heats in both ionogenic and non-ionogenic solutions. With the latter the specific heat of the solution is approximately an additive relation between solvent and solute. With electrolytes the specific heat of the solution may be less than that of the contained water alone. This is due to the influence of a powerful non-homogeneous electric field exerted by the ionic charges and leading to polarisation. A lowering of the specific heat is also brought about by the known influence of the high pressure exerted by the field, and this is estimated to reach values of about 50,000 atmos. A further factor which also determines the activity coefficient is the ionic atmosphere or space charge of opposite sign which surrounds each ion. An internal energy, which, by the Boltzmann principle, is estimated to be proportional to the square root of the concentration, is thus introduced. The electrical polarisation and ionic atmosphere are diminished by rise of temperature. Hydration of the ions also modifies the specific heat, and in some instances, through the heat of dissociation of the hydrates, this factor more than counterbalances the influence of electrical polarisation. The influence of these different factors is deduced thermodynamically, and formulæ derived to express the specific heats of solutions in terms of the different constants involved. The bearing on these conclusions of the theories of Arrhenius, Milner and Debye, and of Tammann is discussed. [See Abstract 324 (1926).] J. N. P.

**2134.** *Thermal Constants of Solid and Liquid Carbon Dioxide.* **O. Maass and W. H. Barnes.** (Roy. Soc., Proc. 111. pp. 224–244, May 1, 1926.)—A detailed description is given of the experimental determination of the specific heat of $CO_2$, solid from 90° Abs. to 194·5° Abs., and liquid to 298° Abs., and of the latent heats of fusion and sublimation. The value obtained for the latent heat of sublimation agrees within 0·6 % of the value calculated from the Clausius-Clapeyron equation. The expansion coefficient of solid $CO_2$ is found to be abnormally large, and it is indicated that the abnormally high results obtained for the molecular heat at constant pressure are connected with this expansion coefficient. The calculation of Trouton's constant from the data obtained in the present work gives it a value 20·7, which places liquid $CO_2$ among the normal unassociated liquids. A. B. C. L.

**2135.** *Nonflammable Liquids for Crystals.* **C. W. Kanolt.** (Bureau of Standards, Sci. Papers, No. 520. pp. 619–633, 1926.)—The object of this investigation was to find liquids that will not burn, that have very low freezing-points, and are otherwise suitable as cryostat liquids. The substances used were $CCl_4$, $CHCl_3$, $CH_2Cl_2$, $C_2H_5Cl$, $C_2H_5Br$, $C_2H_2Cl_2$, and $C_2HCl_3$, and tests were made of their "flammability" (the term used by the American Society for Testing Materials), their freezing-points, their viscosities (some of the mixtures were too viscous at low temperatures to be stirred efficiently), and their corrosive action on metals. The following are recommended: $CCl_4$ to − 23° C.; $CHCl_3$ to − 63° C.; $CCl_4$ 49·4 + $CHCl_3$ 50·6 to − 81° C.; $C_2H_5Br$ to − 119° C.; $CHCl_3$ 19·7 + $C_2H_5Br$ 44·9 + $C_2H_2Cl_2$ 13·8 + $C_2HCl_3$ 21·6 to − 139° C.; $CHCl_3$ 14·5 + $CH_2Cl_2$ 25·3 + $C_2H_5Br$ 33·4 + $C_2H_2Cl_2$ 10·4 + $C_2HCl_3$ 16·4 to − 145° C.; and $CHCl_3$ 18·1 + $C_2H_5Cl$ 8·0 + $C_2H_5Br$ 41·3 + $C_2H_2Cl_2$ 12·7 + $C_2HCl_3$ 19·9 to − 150° C. T. B.

**2136.** *On the Processes occurring in the Interchanger of a Gas-liquefying Apparatus.* **W. Meissner.** (Zeits. techn. Physik, 7. 5. pp. 235–238, 1926. From the Reichsanstalt.)—The author obtains the equations for the flow of heat along the tubes of the interchanger and for the flow of heat at right angles to these tubes. Assuming that the loss of heat from the outside of the interchanger and also the conduction along its tubes can be neglected, the author finds that $\frac{dT_h}{dl} < \frac{dT_r}{dl}$ for all values of *l*, *i.e.* the length of the interchanger. As $T_r$ increases more rapidly than $T_h$ as the length *l* increases, at the upper end we can have $T_r = T_h$ if *l* is big enough, and we get no loss of heat from the expanded gas. In order to prevent as far as possible the flow of heat downwards to the lower end of the interchanger, which is illustrated diagramatically in the figure (this flow tending to prevent $T_r$ becoming equal to $T_h$), it is advisable to make the tubes of nickel silver, as was done by the author at the Reichsanstalt in the case of the helium liquefier. T. B.



**2137.** *Two Rapid and Accurate Methods in Calorimetry.* **W. P. White.** (Am. Chem. Soc., J. 48. pp. 1146–1149, May, 1926.)—The author points out that by a simple modification of the usual formula for the cooling correction one is obtained in which the "thermal leakage factor" of the calorimeter enters, and this is a quantity which may be determined once for all. Thus the observations necessary for determining the cooling correction are reduced in number without loss of accuracy. The second method consists in reducing the number of "experimental-period" observations for constant accuracy by using Simpson's rule for summation instead of the more usual method. Data on an actual heating curve are quoted to illustrate the advantages. E. G.

**2138.** *Gas Thermometric Investigations with Helium, Neon, Nitrogen and Oxygen.* **W. Heuse.** (Zeits. f. Physik, 37. 3. pp. 157–164, 1926. From the Reichsanstalt.)—The earlier-derived limiting value of the pressure and expansion coefficients of gases, $\gamma = 0{\cdot}0036604$ [see Abstract 589 (1922)], is now supported by new observations with neon, the influence of gas adsorption on gas thermometric measurements being investigated. The difference between the inclination of the 0° isotherms, already observed for helium, which is found by piezometer experiments at higher pressures, and directly observed at about 1 m. mercury, has also been established for neon, nitrogen and oxygen. Systematic variation of the experimental conditions was without influence on this result. Should further investigation show that this is due to a systematic error in the pressure measurements, then the data for $\beta$ and $\gamma$ must have been improved. The author states that the earlier-derived limiting value for the pressure and expansion coefficients (*loc. cit.*) is correct to 0·1 %. H. H. Ho.

**2139.** *Copper Covers for Calorimeter Jackets.* **W. P. White.** (Am. Chem. Soc., J. 48. pp. 1149–1154, May, 1926.)—An experimental investigation of the reliability of a copper cover to a calorimeter jacket. The author concludes that the most satisfactory arrangement is a cover over the jacket, bent down to dip into the water of the outer jacket. Outside this should be a second similar cover, which may carry thermal insulation. It is claimed that this arrangement can be used without hesitation for a precision of 3 in 10,000, and is thus hardly inferior to the more elaborate submarine, or water cap, methods of shielding. E. G.

**2140.** *Flow of Gases at High Speeds.* **T. E. Stanton.** (Roy. Soc., Proc. 111. pp. 306–339, June 2, 1926.)—The late Lord Rayleigh [see Abstract 1100 (1916)] suggested that further investigations should be made on the adiabatic character of the flow of a gas under high pressures and its dependence on the pressure in the receiver. In the present paper reference is made to the work of St. Venant and Wantzel (who ignored the possibility of any variation in the area of the jet); of R. D. Napier and H. Wilde (who observed the rate of discharge to become constant at values of $p_r/p_0$ about 0·5, where $p_0$ is the pressure in the throat of the orifice, $p_r$ that in the receiver); of Osborne Reynolds,, Hartshorn and others. All the results indicate that a constant rate of discharge is obtained when the receiver pressure is the theoretical value for the pressure at the minimum section, *i.e.* $p_r = 0{\cdot}527\, p_0$.

The present author has studied the distribution of pressure and velocity in jets flowing through various forms of orifices, with special reference to (1) the existence of a minimum section of the jet and its position and magnitude; (2) the relation between the pressures in receiver and jet for increasing and constant rates of discharge; (3) effects of dimensions of orifice and viscosity of air on the characteristics of high-speed jets. In addition, a study has been made of the motion of jets at speeds above the velocity of sound and the nature of the wave motion set up on their emergence into quiescent air. Many of the results are shown diagrammatically, and shadowgraphs by the Dvořák method, as used by Emden, are given of jets from orifices of various shapes. T. B.

**2141.** *The Cooling of Hot Bodies in Gases and Liquids. Part II.* **J. Schmekel.** (Phys. Zeits. 27. pp. 332–344, May 15, 1926.)—This is a mathematical paper dealing with the cooling of a hot body due to a flow of fluid past the body, and forms an extension and conclusion to the work of Seeliger on the cooling of a hot body in a fluid at rest [see Abstract 1692 (1925)]. The hydrodynamical equations are discussed for some of the simpler cases, first without taking account of viscosity and then taking it into account in the equations. The case of turbulent flow is dealt with. The work of Nusselt, Davis, Latzko and Boussinesq is discussed and a comparison with the results of experimental work is made with the help of graphs. A large number of references to the literature of the subject is given. T. B.

**2142.** *Ignition of Gases by Sudden Compression.* **H. T. Tizard** and **D. R. Pye.** (Phil. Mag. 1. pp. 1094–1105, May, 1926.)—In a previous paper [see Abstract 2477 (1922)] it was shown that the ignition of gases by sudden compression could be explained quantitatively by the theory that at the temperature of compression the gases react at such a rate that heat is evolved faster than it is lost by conduction to the walls of the vessel. The object of the present experiments is to examine the theory more closely. For this purpose the apparatus has been modified in such a way that the gases can be preheated to 150°–180° C. The compression ratio can thus be reduced to 6 : 1. It is shown that (with a time of compression of 0·14 sec.) the maximum pressure reached by compression is always considerably lower than that calculated on the assumption that compression is adiabatic. This is due chiefly to loss of heat during compression. Further experiments on the period of delay between attainment of the maximum compression temperature and the actual explosion show that there is usually (but not always) a fall of pressure during the "delay" period. The actual amount of heat generated by combustion during this period must therefore be small. It is also shown that ignition can occur even when the main body of the gas has cooled down to a temperature well below the temperature just after compression. Hence it is clear that ignition is initiated by quite a small portion of the gas. A general conclusion is reached that for substances liquid at ordinary temperatures reaction proceeds at a rate which is conditioned by temperature, and that ignition or non-ignition depends on the rate of loss of heat at this temperature. T. B.

**2143.** *Emissivity of Bismuth in a Magnetic Field.* **C. W. Heaps.** (Phys. Rev. 27. pp. 764–768, June, 1926.)—Electromagnetic theory and the experiments of Hagen and Rubens lead to the formula $\delta E/E = \delta\sigma/(2\sigma)$, where $\delta E$ is the change produced in the emissivity E of a metal for long heat waves by a change $\delta\sigma$ in the electrical conductivity $\sigma$. Using a thermophile to detect $\delta E$, a magnetic field of 4900 gauss was used to produce the $\delta\sigma$ in bismuth plates kept at about 100° C. No effect of the field on E was observed for polished surfaces, surfaces etched with nitric acid, or surfaces of a plate cast in vacuum. A change of E ten times smaller than the expected result could have been detected. Possible causes of the negative result are (1) the presence of emitted energy of too short a wave-length, (2) the absence of magneto-resistance in bismuth for high-frequency currents, and (3) the absence of magneto-resistance in surface layers of bismuth. Reasons are given for rejecting (1) and (2) and accepting (3) as an explanation of the experiment. AUTHOR.

**2144.** *Influence of Radiation on Ionisation Equilibrium.* **M. Saha** and **R. K. Sur.** (Phil. Mag. 1. pp. 1025–1034, May, 1926.)—Ehrenfest's theoretical treatment of dissociation, which deals with the thermodynamical equilibrium of a mixture of gases at a given temperature, is extended to include the effect of radiation by counting radiation of a given frequency, and of a "temperature" not necessarily the same as that of the gases, as one of the phases taking part in the equilibrium. The method employed is to consider the effect of a virtual displacement which consists in the reduction by one each of the numbers of neutral atoms and energy quanta in a given space, and the increase by one each of the numbers of electrons and ionised atoms, the system consisting of four phases. A relation is obtained which reduces to known forms in particular cases: *e.g.* it can be reduced to a formula of Einstein for photo-chemical reactions. Similarly, formulæ are deduced for the equilibrium between atoms in the normal state, atoms in any given excited state, and radiation of a given frequency. The formulæ are regarded as approximate only, since they do not account for the finite width of absorption lines. C. W. H.

**2145.** *The Second Law of Thermodynamics.* **W. F. Sedgwick.** (Phil. Mag. 1. pp. 1286–1288, June, 1926.)—A discussion of the methods of expression of the second law of thermodynamics due to W. Thomson, Tait, Maxwell, W. M. F. Orr and Clausius. It is shown that it is preferable to found the theory on Kelvin's axiom, which connects itself with the kinetic theory of heat, and has the advantage, as compared with that of Clausius, of necessitating the consideration of one temperature only instead of two. S. G. B.

**2146.** *Thermodynamics of Non-isothermal Systems.* **E. D. Eastman.** (Am. Chem. Soc., J. 48. pp. 1482–1493, June, 1926.)—The first and second laws are applied to the deduction of the equilibrium conditions in a number of interesting non-isothermal systems. The equilibrium pressures in systems exhibiting thermal endosmosis are shown to depend upon the heat of solution of the substance in the dividing membrane. The conception of osmotic temperature is lacking in significance because it depends upon the properties of the membrane as well as of the solution. The Soret effect, or thermal diffusion, in perfect solutions is considered to be entirely the result of irreversible processes and not to represent a thermodynamic equilibrium. In imperfect solutions it consists in part of a reversible effect, equations for which are derived. The compositions of solutions at different temperatures connected with each other through a vapour phase are discussed as examples of heterogeneous non-isothermal equilibria. The equations of the thermocouple are deduced. The precise significance of the quantities in the thermo-electric equations is stated, and the way in which the reversible and irreversible Soret effects may be expected to influence the phenomena is indicated. Non-electric thermocouples furnishing interesting analogies to the electric are considered. Finally, certain thermo-cells, consisting of similar electrodes at different temperatures, are discussed. J. E.

## SOUND.

**2147.** *Choice of Striking-point in Pianoforte.* **R. N. Ghosh.** (Phil. Mag. 1. pp. 875–885, April, 1926.)—Deals with the impact of actual felt-covered pianoforte hammers upon steel strings, the yielding of the felt being taken into account. From the experimental results of the analysis of different vibration curves obtained by striking the string at different points with the same velocity the author concludes that the fundamental is a maximum when the ratio of the period ($\theta$) of the fundamental to the duration ($\tau$) of the impact is unity, and again when the ratio is equal to 2. In the latter case the first and second harmonics are stronger than in the former. He also concludes that (i) the striking-point in a piano is made so as to obtain $\theta/\tau = 2$; (ii) the sound-board reproduces the maximum vibration of the string at $\theta/\tau = 2$; and (iii) the striking-point should lie between 1/9 to 1/7 of the length of the string. W. H. Ge.

**2148.** *Resonant Acoustic and Electric Oscillations.* **C. Barus.** (Nat. Acad. Sci., Proc. 12. pp. 137–140, March, 1926.)—Electric oscillations released by a spring break are used to detect very low notes associated with very short, thin pipes. [See also Abstract 1617 (1926).] A. C. M.

**2149.** *Law of Depth Reception in Acoustics and Electro-acoustics.* **W. Schottky.** (Zeits. f. Physik, 36. 9–10. pp. 689–736, 1926.)—Referring to the transmission and reception of sound waves, the author points out that although a principle of reciprocal action has been stated by Helmholtz and generalised by Rayleigh, separate theories are extant for explaining transmission and reception. The reason for this is because the efficiency of an apparatus is not the same for transmission as for reception, the two differing in their dependence on the frequency. This difference increases towards the region of low frequencies, and the law of "depth" reception is stated thus: Any acoustical radiator, whose motion is linear and determinable in terms of one coordinate, is capable of absorbing, from unit solid angle of an incident uniform spherical wave of length $\lambda$ and radius R, an amount of energy which is smaller, in the proportion $\lambda^2/R^2$, than the amount which it is capable of sending per unit angle in the direction of the centre of this wave. The principle applies to all kinds of radiation for which the reciprocal theorem holds. The paper is in three parts: the first deals chiefly with the proof of the above law; the second with its application to problems in pure acoustics, such as the theory of the conical ear-trumpet. In the third part is brought out the difference, in reversible electro-acoustic apparatus, between their microphonic and their loud-speaker qualities. G. E. A.

**2150.** *The Law of Depth Reception in the Classical Theory of Radiation.* **W. Schottky.** (Ann. d. Physik, 79. 6. pp. 557–571, April 6, 1926.)—Planck's law of the mean energy of an oscillator, in terms of the wavelength and intensity of radiation, is dealt with as a special case of the law of depth reception [see preceding Abstract], and is shown to be applicable to electrical and acoustical oscillators. The question is raised whether the law of depth reception can be formulated in terms of the quantum theory. G. E. A.

# ELECTRICITY AND MAGNETISM.

## THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

**2151.** *Radiation of Energy and Angular Momentum.* **H. Bateman.** (Phys. Rev. 27. pp. 606–617, May, 1926.)—A continuation of previous work dealing with the modification of electromagnetic theory to justify non-radiating electronic orbits. Given an electromagnetic field derived from retarded potentials, it is generally possible to add a scalar field derived from a retarded potential $\psi$, so that the total radiation of energy to infinity is zero for each direction. The radiation of angular momentum to infinity is not zero for each direction unless the electromagnetic field is of a certain type. The approximate values of the field vectors at a great distance from the origin are expressed in terms of a quantity $a$, which satisfies a given partial differential equation when the field is of this type. Some remarks are made on the attempts which have been made to solve the problem with the aid of electromagnetic fields alone, and a brief discussion is given of the classical theory of radiation of angular momentum. W. H. Ge.

**2152.** *Transformation of Prequantic Equations.* **R. Ferrier.** (Comptes Rendus, 182. pp. 963–965, April 19, 1926.)—Einstein showed, in 1905, that the magnetic field equations, according to the Maxwell theory (field not divergent in the absence of masses), transform into themselves when the change of variables is defined by the Lorenz group. Study of the electric field in the presence of quantic phenomena led the author to consider the following equations which determine the phenomena during the period immediately preceding the formation of singular points in the ether (Planck's oscillators). In them $\Omega$ represents a scalar quantity which the author calls the "amperien," which holds, in a certain manner, in the irrotational electric fields here considered, the place of the magnetic field without divergence alone considered by Maxwell. The prequantum equations are:

$$\frac{\partial Z}{\partial y}-\frac{\partial Y}{\partial z}=0,\quad \frac{\partial X}{\partial z}-\frac{\partial Z}{\partial x}=0,\quad \frac{\partial Y}{\partial x}-\frac{\partial X}{\partial y}=0,\quad \frac{\partial \Omega}{\partial x}=-\frac{1}{c}\frac{\partial X}{\partial t},$$

$$\frac{\partial \Omega}{\partial y}=-\frac{1}{c}\cdot\frac{\partial Y}{\partial t},\quad \frac{\partial \Omega}{\partial z}=-\frac{1}{c}\frac{\partial Z}{\partial t},\quad \frac{\partial X}{\partial x}+\frac{\partial Y}{\partial y}+\frac{\partial Z}{\partial z}=\frac{1}{c}\frac{\partial \Omega}{\partial t}$$

These equations transform into themselves, not by the Lorentz transformation, but by the conjugate transformation obtained by replacing $c^2$ by $-c^2$. This shows that the *universe interval*, given by Minkowski and adopted by Einstein, can fit quantic phenomena only when $c^2$ is replaced by $-c^2$. It does not seem, therefore, that the relativity scheme, in the sense in which this term is now accepted, can comprehend simultaneously the laws of propagation and the quantum laws, determined by two different sets of equations. G. W. de T.

**2153.** *Establishment of a Steady State in Electrical Circuits.* **A. Blondel.** (Comptes Rendus, 182. pp. 1108–1112, May 10, 1926.)—An entirely mathematical paper dealing with the method of integration of the differential equations. **A. Wh.**

**2154.** *Electrostatic Field due to any Number of Thin, Cylindrical, Electrified Conductors whose Axes are Parallel.* **U. Cisotti.** (Accad. Lincei, Atti, 3. pp. 289–293, March 21, 1926.)—Given a plane at right angles to the axes of the cylinder, the problem is to determine the electrostatic potential, a harmonic function in the unlimited region of the plane external to all the circumferences (sections of the cylindrical superficies with the plane), assuming a constant value on each circumference and such that its gradient (electric force) be regular in the aforesaid region and become zero at infinity, these being the usual conditions which a logarithmic potential should satisfy. Entirely mathematical. **E. F.**

**2155.** *Breaking of Water Drops by Electric Fields.* **J. J. Nolan.** (Roy. Irish Acad., Proc. 37. pp. 28–39, May, 1926.)—Tests were applied experimentally to examine conclusions of Wilson and Taylor [Abstract 2331 (1925)] regarding the maximum size of a water drop which can exist in an electric field in the atmosphere. Illuminated uncharged drops of distilled water of different sizes fell at a slow rate between a pair of almost flat plates connected to a Wimshurst machine and having Leyden jars in parallel with it. The drops were observed visually to undergo (1) explosive bursting whatever the size of the drops for values of the field given by $F\sqrt{r} = 3880$, where F is the field intensity in volts/cm. and $r$ the radius of the drop in cm., this agreeing approximately with Wilson and Taylor's results; and (2) a type of disintegration for drops larger than 0·2 cm. radius for field strengths given approximately by $Fr^{5/3} = 600$. Measurements of the charge carried by the broken drops were unsuccessful, but it was found that a sudden increase in the charging of the collecting vessel occurs for results agreeing with those obtained visually on the explosive bursting of drops. The application of the results to the behaviour of raindrops in atmospheric electric fields is considered. **R. S. R.**

**2156.** *Theory of Electrostatic Alternators.* **A. W. Simon.** (Phys. Rev. 27. pp. 747–754, June, 1926.)—A more elegant method than that previously given for the solution of the equations involved in the theory of electrostatic alternators is given, and illustrated by application to an electrostatic alternator of eight inductors and eight carriers, in which each carrier as it comes in front of an inductor is connected to the next following inductor by means of a brush and insulated arm. The method can be extended to the solution of electrostatic alternators of $m$ carriers and $m$ inductors, where each carrier is connected to the inductor next following, also where each carrier is connected by means of brushes properly placed to the $p$th inductor following. It may also be applied to electrostatic alternators with $m$ inductors and $2m$, $3m$, or $4m$ carriers and to electrostatic alternators of the Wimshurst type. With regard to the eight-inductor alternator it is shown that three waves travel around the machine with periods corresponding to the time of 2 revolutions, 1 revolution and 2/3 revolutions. The amplitude factor for each wave per eighth revolution is calculated approximately. Finally, the effect of the initial conditions (potentials) on the action of the machine is discussed.

It is shown that the potentials of the inductors of the machine eventually lag $\pi/4$ behind each other. [See Abstracts 1447 and 2561 (1925).]

AUTHOR.

**2157.** *Discussion on the Electrical State of the Upper Atmosphere.* (Roy. Soc., Proc. 111. pp. 1–13, May 1, 1926.)—**E. Rutherford** dealt with new direct lines of attack on the problem of the constitution and electrical state of the upper atmosphere, and in particular with the reflection or refraction of waves at night-time. He opines that the main discussion should centre round the following points: (1) The mean free path of electrons and the rate of recombination of ions at various heights in the upper amtosphere; (2) the magnitude and origin of this ionisation; (3) the amount and distribution of ionisation required to explain the observations upon downcoming electric waves both as regards intensity and polarisation; (4) are the downcoming electric waves due to reflection or to refraction of the incident beam by an ionised layer? **S. Chapman** discusses measurements of pressure, density and temperature, including the composition at 90 or 100 km., as of interest in connection with the auroral spectrum. He concludes by supporting the thickness of the conducting layer as of the order of 200 or 300 km. without assuming an excessive specific conductivity. **C. T. R. Wilson** suggests that thunderstorms are by no means the least important factors which determine the electrical state of the upper atmosphere, since the power expended in producing lightning by all the thunder-clouds in action at a given time is of the order of $10^{19}$ ergs per sec., *i.e.* about 1/10,000 of the energy received by the earth from the sun per sec. The large e.m.f. of a thunder-cloud is held likely to make it act as a source of $\beta$-rays and of X- and $\gamma$-radiations of energies ranging from $10^4$ to $10^9$ volts, *i.e.* up to values exceeding the energy of the hydrogen nucleus and corresponding to the most penetrating type of radiation that has been imagined. Penetrating $\beta$-rays from thunder-clouds may traverse the upper atmosphere, and under the influence of the magnetic field re-enter the atmosphere in widely scattered regions, contributing parhaps to auroral phenomena and to the penetrating radiation, studied by Kolhörster and recently by Millikan, to which a cosmical origin has generally been assigned. **H. Jackson** discusses fading effects in connection with the Kennelly-Heaviside layer theory. He considers that the layer must exercise but little attenuation on short waves, which show small loss of energy in their passage along it, and that it appears to deflect down some wave-lengths at various places some distance apart, and others possibly at all points on the earth's surface, and that two or more waves must sometimes reach the receiver at varying and different phases of their oscillations to account for the extraordinary fading effects that are so often noticed with them. He wonders whether a layer that will fulfil all these functions is a physical possibility. **E. V. Appleton** describes two methods specially suitable for investigating the upper atmosphere by means of short-distance transmissions, the application of which has yielded a direct experimental proof of the existence of the ionised layer. He points out that the study of atmospheric influences on ultra-short wave transmission leads to a theory of imprisoned and escaping rays and wave-lengths. The rays deviated by the atmosphere are found to be in general elliptically polarised, and the influence of the magnetic field is most marked when the mean free path of the electron is large. Diurnal variations of wireless phenomena all seem to be explicable by assuming that the under boundary of the effective stratum is higher at night (80 — 120 km.) than during the day (50–70 km.). **R. L. Smith-Rose** (with **R. H. Barfield**) discusses experiments on wave-lengths of about 400 metres which gave direct proof of the existence of downcoming waves. **W. H. Eccles** reviews agencies and theories other than the Heaviside hypothesis. **G. M. B. Dobson** supplies evidence entirely different from that afforded by radio-telegraphy, *viz.* from the heights of meteors, that the upper atmosphere is considerably ionised. **F. A. Lindemann** criticises Wilson's suggestions, which, however, he cannot accept for the production of the required ionisation, and he supports R. d'E. Atkinson's view that the persistence of ionisation through the night would be accounted for if the ozone produced by the sun's radiation broke up into ions. [See Abstract 932 (1926).] H. H. Ho.

**2158.** *Electrical State of the Lower Atmospheric Layers on Clear Days at Pawlowsk* (1916 *to* 1920). **W. N. Obolensky.** (Meterorolog. Zeits. 43. pp. 173–177, May, 1926.)—Observations of (1) electric field intensity, (2) electric conductivity, and (3) vertical electric current have been used to give mean hourly values. Graphs show the variations of these elements throughout the twenty-four hours for the four seasons and for the year. The mean values of (1) and (2) are nearly opposite in phase. Diurnal changes of (1) show two maxima and two minima, the mean value being 189 volts/metre and the daily amplitude 59 % of this. Seasonal curves differ considerably, with winter values higher than summer ones. The annual changes show a maximum in February and a minimum in June. For (2) the mean values found are $\lambda_+ = 117 \times 10^{-6}$, $\lambda_- = 96 \times 10^{-6}$ and $\lambda = 213 \times 10^{-6}$ E.S.U. The ratio $\lambda_+/\lambda_-$ is large compared with values found elsewhere. For (3) in summer a mean value of $104 \times 10^{-6}$ E.S.U. is found, but in winter the oscillations are weak. Large oscillations of all the three elements occur during fog and during snowstorms, and an explanation is given for the large excess of positive charges in a fog and of large negative potential gradients in snowstorms. [See also Abstract 145 (1926).] R. S. R.

**2159.** *Lightning.* **G. C. Simpson.** (Roy. Soc., Proc. 111. pp. 56–67, May 1, 1926.)—Three possible forms in which lightning discharge may occur in the atmosphere are considered: (1) between a cloud and the ground, (2) between two parts of the atmosphere possessing volume charges of opposite kind, and (3) between a part of the atmosphere having a volume charge and another part having no initial volume charge. An explanation of the discharge is given and the theory illustrated by laboratory tests. It is shown that (1) the conducting channel of a lightning flash originates in the region of maximum electric intensity and develops only in the direction of the seat of negative electricity; (2) a negatively charged cloud can only be discharged by a discharge which originates in a positively charged cloud or in the induced positive charge on the earth's surface; (3) a positively charged cloud may be discharged by discharges starting in the cloud and terminating either in the surrounding atmosphere or on the earth's surface; (4) if a lightning flash is branched, the branches are always directed towards the seat of negative electricity. These conclusions are applied to a large number of photographs of lightning discharges and the preponderance of the lower clouds from which lightning discharges proceed to be positively charged. R. S. R.

## DISCHARGE AND OSCILLATIONS.

**2160.** *Scattering of Positive Rays by Hydrogen.* **G. P. Thomson.** (Phil. Mag. 1. pp. 961–977, May, 1926.)—In an earlier paper [see Abstract 732 (1923)] an account was given of measurements made on the scattering of positive rays from hydrogen in hydrogen gas. The results were not such as could be explained on the assumption of the inverse square law of force acting between the protons and electrons. The rays in these first experiments were measured by passing them through a slit of variable width into a Faraday cylinder and observing the rate at which it gained charge. These earlier experiments are considered as giving only the order of the effect, and it is thought best to make further experiments by comparing the blackening caused in a photographic plate by the scattered and unscattered portions of a beam of positive rays which are allowed to strike it. The density-exposure curve for positive rays is shown to be similar to that for light. The angles investigated are of the order of $\frac{1}{2}°$ and the scattering is shown to be "single." The results obtained differ widely from what would be expected on the inverse square law, there being an excess of rays scattered through the larger angles. The variation with the speed of the rays is also different from what would be expected. The collision relation is found to be of the form $N\alpha\theta^{-2}d\theta$, where N is the chance of a particle being scattered between $\theta$ and $\theta + \delta\theta$ by one encounter. This relation is what would result from centres of force acting as the inverse cube. A. E. G.

**2161.** *Conductivity of Clouds Dispersed from an Arc.* **H. P. Walmsley.** (Phil. Mag. 1. pp. 1266–1281, June, 1926.)—When an electric arc is produced between metallic electrodes in air a cloud of fine particles is dispersed. Some of the particles are visible in the ultramicroscope and show marked Brownian movement. Hitherto they have been of interest mainly in connection with the quantitative study of Brownian motion and the validity of Einstein's formula for the displacement. By direct observation with the ultramicroscope, De Broglie found for particles from arcs in which Tn, Pt and Ag electrodes were used, that some were charged positively, some negatively, and others were neutral. Ehrenhaft and others have employed the charged particles in determinations of the charge carried by the electron. The presence of charged particles should give conductivity to the cloud, and the experiments of McClelland on an arc between Pt electrodes show that this is the case. He also showed that the mobility of the ions from Pt decreased as the distance between the arc and the electrodes was increased, other conditions remaining constant. It is clear, however, that by using his method, the process can be followed only over a short stage in the life of a cloud. The present experiments are undertaken to follow the process over a more extended period. Types of ionisation curves obtained from cadmium oxide clouds produced in dry air free from dust and $CO_2$ by an arc discharge are described. In the later stages of the cloud the ions present at any time are not of uniform mobility. The average mobility of the ions in the cloud and the mobility of the slowest moving ions present at any time diminish as the cloud ages. The dimensions of the ions and the dimensions of the particles in the clouds are of the same order of magnitude, which indicates that the ions are the charged particles of the cloud. The changes in mobility show that coagulation of the particles occurs as the cloud ages. Under certain circumstances, the ionisation curves, after decreasing owing to recombination of ions, subsequently show a rise in current strength and become oscillatory. On the usual assumption that the ionisation current is proportional to the ionisation in the cloud, this indicates that a production of new charges occurs as the clouds age. The new charges appear mainly on particles of low mobility. A. E. G.

**2162.** *Loss of Velocity of Kathode-rays in Matter.* **P. Lenard.** (Ann. d. Physik, 80. 1. pp. 1–16, May 18, 1926.)—A general survey of the work which has been done on the subject. The author does not claim to have here contributed anything new. A. E. G.

**2163.** *Secondary Rays and Absorption of Kathode-rays.* **P. Lenard.** (Ann. d. Physik, 80. 1. pp. 17–32, May 18, 1926.)—Reference is made to a paper by J. B. Johnson on secondary rays, which it is claimed is little known, and its influence on the knowledge of the motion of electrons in matter is briefly discussed. Some remarks on absorption are also made. A note on recent work by Kulenkampff is added. A. E. G.

**2164.** *The Photoelectric Effect in Extreme Vacuum and its Dependence on Pressure.* **O. Rietschel.** (Ann. d. Physik, 80. 1. pp. 71–108, May 18, 1926.)—It is here shown that an improvement of tube vacuum lowers the gas charging of the photo-metals and increases the photoelectric effect, while a lowering of the vacuum has the opposite effect. A very good tube vacuum hinders the gas charging of a well de-gassed photo-metal and makes it possible to obtain a pure metal effect; on the other hand, a poor tube vacuum increases the conductivity in the tube and makes it appear that there is a high photoelectric effect. A metal which has been well de-gassed in a relatively good tube vacuum causes a high photo-effect, but in a poor tube vacuum a small or vanishing photo-effect. The photoelectric effect depends neither upon the de-gassed condition of the photo-metal alone, nor on the tube alone, nor on the absolute height of both alone, but only on the gas condition of the metal surface. With diminishing surface gas charging the photoelectric effect increases. A. E. G.

**2165.** *Kathode Scattering. I. Electrochemical Scattering.* **A. Güntherschulze.** (Zeits. f. Physik, 36. 8. pp. 563–580, 1926. From the Reichsanstalt.)—The kathode scattering of 24 elements in hydrogen is investigated qualitatively. With C, Se, Te, As, Sb, Bi, special appearances are obtained which are known to be caused by an electrochemical kathode scattering. A systematic comparison of these different appearances with the normal gives the following results: (1) *Normal.* The scattered metal is deposited at pressures of the order 1 mm. on the walls of the vessel directly over the kathode. *Electrochemical.* The walls of the vessel directly over the kathode remain completely free from deposits. (2) *Normal.* If the anode and kathode are brought closer together the quantity scattered increases strongly and is greatest with the smallest possible electrode distance. *Electrochemical.*—The quantity scattered is practically independent of the distance between electrodes. (3) *Normal.* There is a straight line connection between kathode fall and quantity scattered.—*Electrochemical.*—There is still a considerable scattering present with normal kathode fall. With As it is very great, with Sb medium, and smallest with Bi. (4) *Normal.* The scattering takes place only at the kathode. *Electrochemical.*—The element is scattered also if it is placed in the path of the discharge without any connection with the electrodes, or if it is used as anode, a proof that the presence of hydrogen ions is sufficient for scattering. A. E. G.

**2166.** *Emission Work with Oxide Kathodes.* **H. Rothe.** (Zeits. f. Physik. 36. 9–10. pp. 737–768, 1926.)—The emission work is determined from a number of oxide kathode tubes by means of the Richardson equation, and extraordinarily low values are obtained. The emission work is also ascertained from the cooling effect, and in the case of saturation it is found to approximate to the results obtained by Richardson's equation method. On the other hand if the emission current is smaller than the saturation current the cooling effect is considerably greater than corresponds to the emission work of the oxide. Fatigue appearances, which occur with nearly all oxide kathodes, are also investigated, and it is thought probable that they are due to decomposition of the oxides. Contact potential has been dealt with previously. [See Abstract 823 (1926).] A. E. G.

**2167.** *Electric Contact of Glowing Platinum in Vacuum.* **H. Rohmann.** (Zeits. f. Physik, 36. 11–12. pp. 803–813, 1926.)—The author has previously shown [see Abstract 148 (1926)] that between platinum electrodes, of which one is cold and the other glowing, in a vacuum at a tension of about 100 volts, a current is produced if the distance between the electrodes is so small that the field strength reaches a value of about 100,000 volts/cm. In the present experiments two platinum wires are used which have glowed for a long time in a vacuum, and attempts are made to cause the passage of current when the field strength reaches a critical value. It is shown that the passage of the current with a kind of electric contact can be made arbitrarily unipolar if the electrode wires glowing under tensions of some 100 volts at some megohm governing resistance are brought in contact and are slowly moved apart. The generation and control of the vacuum, and the gold-leaf manometer used are described in detail with diagrams. A. E. G.

**2168.** *Photoelectric Distribution of Sensitiveness and the Red Limit.* **E. Rumpf.** (Zeits. f. Physik, 37. 3. pp. 165–171, 1926.)—A mathematical discussion of recent observations [see Abstracts 2337 (1925) and 370 (1926).] The Werner quadratic formula gives only an approximate expression for the spectral distribution of sensitiveness. For the metals which correspond to it, Becker's cubic formula agrees with experimental results at some distance from the red limit, but does not hold good in its vicinity. An empirical formula is suggested, calculating the red limit according to Suhrmann and passing over into Becker's cubic formula for short waves. Speaking generally, conclusions concerning the red limit can be drawn from observations on the distribution of sensitiveness only where there is "double decomposition" of the exciting light, and then only when Suhrmann's postulate of the dependence of the red limit on temperature in a positive or negative sense is experimentally established. **Errata** (*ibid.*, 37. 9. p. 704, 1926). E. F.

**2169.** *Penetration of Glass.* **Lydia Inge** and **A. Walther.** (Zeits. f. Physik, 37. 4-5. pp. 292-303, 1926.)—The authors have previously shown [see Abstract 150 (1926)] that in rock-salt at high temperatures the electric penetration can be accounted for by the theory of heat with very great accuracy. In the present paper the penetration tension for glass at different temperatures is investigated, and it is found that the whole range of temperatures can be placed into two groups: One, which corresponds to the higher temperatures in which the penetration tension depends on the temperature, the other corresponding to low temperatures where no such dependence is indicated. It is shown that at the higher temperatures the most important demands of the theory of heat on the corresponding penetration are fulfilled. At the lower temperatures the penetration cannot be explained by the theory of heat, but here another mechanism is responsible, in which the degree of inhomogeneity of the electric field plays a very important part. A. E. G.

**2170.** *Cold Electron Charging in Highly Evacuated Glow-Lamps.* **P. Selényi** and **E. Tarján.** (Zeits. techn. Physik, 7. 5. pp. 232-235, 1926.)—Certain remarkable electrostatic phenomena are observed when vacuum lamps are examined by means of Tesla currents, which tend to show that the charging up of the lamp through the Lilienfeld kathode-rays is to be explained by the discharge through positive ions from the glowing wire. A. E. G.

**2171.** *Variation with Pressure of the Residual Ionisation in Gases.* **W. W. Merrymon.** (Phys. Rev. 27. pp. 659-671, June, 1926.)—The residual ionisation in aged, dry, and dust-free air, $H_2$, He, A, $O_2$, $N_2$, $CO_2$, $CH_4$ and $C_2H_4$ has been measured at pressures from 0 to 180 cm. Hg. In order to reduce radio-active contamination a glass globe with a sputtered silver coating was used as the ionisation chamber. An electrometer and compensation devices eliminated the effect of fluctuations in the battery and provided a null method that kept the guard ring at the same potential as the collecting system, thus eliminating leakage. The ionisation curves show a more rapid rise in the lower pressures which ceases at from 15 to 65 cm. Hg, when the alpha-rays causing it are absorbed. Above this the curves are straight lines. From these portions the increase in ions formed per c.c. per sec. per atmos. has been determined. It is least in the case of hydrogen (2·033), and largest in the case of argon (18·59). This rate divided by the number of electrons in the molecule is approximately constant (0·855). The rather good agreement with Kleeman's beta-ray results might be regarded as an indication that the principal agency operative was of a beta-ray character. AUTHOR.

**2172.** *Spectrographic Examination of the Striated Discharge in Mixed Gases.* **D. A. Keys** and **M. S. Home.** (Phys. Rev. 27. pp. 709-715, June, 1926. Abstract of paper read before the Am. Phys. Soc., Dec., 1925.)—The present paper contains the results of a spectroscopic examination of the striated discharge in (1) a mixture of nitrogen and hydrogen,

(2) a mixture of helium and hydrogen. Spectrograms were taken of the light emitted by the negative glow and by the striations respectively. The electronic energies in the different regions of the discharge are interpreted from these spectra in much the same manner as that first suggested by Saeliger and now used by astrophysicists to determine the extent of ionisation in different stars and in various levels of the sun's atmosphere from the spectra of their regions. In the nitrogen mixture the Balmer lines and the nitrogen bands 4708, 4278 and 4236 were found to appear in the negative glow but to be absent from the striations. Interpreting this result in terms of electronic energies (or equivalent quanta, if radiation) there are relatively few electrons possessing energy equivalent to 15·5 volts in the striations though the potential applied to the discharge tube was about 1100 volts. In the mixture of helium and hydrogen, the Balmer lines are strong in the striations but relatively weak in the negative glow. The line spectrum of helium was strong in the negative glow but weak or absent in the striations. The mercury-arc lines were equally strong in both parts of the discharge. In terms of electronic energies, these results mean that there are relatively few electrons possessing energy equivalent to 25·3 volts in a striation but plenty possessing energies of 10·4 and 15·5 volts. An explanation is suggested of the change in intensity of certain lines in mixtures of different gases. AUTHORS.

**2173.** *Formation of Negative Ions in Mercury-Vapour.* **W. M. Nielsen.** (Phys. Rev. 27. pp. 716–723, June, 1926.)—The method used is similar to that of Mohler [see Abstract 827 (1926)]. Electrons, projected along the axis of a tube between two plates were prevented from scattering by a magnetic field of 350 gauss parallel to the axis of the tube. Negative ions formed by the attachment of an electron to an atom or to a molecule were removed by suitable potentials applied to the side plates. The remainder of the current reached a circular plate at the end of the tube. With a small field between the side plates, the negative ion current was just barely observable ($1 \times 10^{-10}$ amps.). With higher fields the ion current increased enormously, approaching saturation when the potential difference between the side plates was increased to between 3 and 4 volts. In this report the ion currents were of the order of $9 \times 10^{-9}$ amps. The total current was of the order of $1 \times 10^{-7}$ amps. The ratio between the negative ion and total current decreases with increase in the driving potential for low voltages, but increases at 2·7, 4·7, 5·5 and 8·8 volts. The decrease at low potentials is similar to the results of Mohler in other gases and vapours. The cause of the break at 2·7 volts is not known. The breaks at 4·7, 5·5 and 8·8 volts are believed to be associated with the electronegative properties of the mercury atom having an electron in a metastable orbit. The total current rises rapidly with increase in the driving potential and decreases at 4·9 and 6·7 volts. AUTHOR.

**2174.** *Probability of Ionisation of Gas Molecules by Electron Impacts. II. Critique.* **K. T. Compton** and **C. C. van Voorhis.** (Phys. Rev. 27. pp. 724–731, June, 1926.)—Corrections to results of Hughes and Klein [see Abstract 1496 (1924)].—Three sources of error are found and approximate corrections for them determined. They are (1) an effect of the electric field on the effective area of holes in the grid through which the primary electrons pass, which introduces corrections varying from

− 18 % at the lowest voltages to + 14 % at 300 volts; (2) presence of slow secondary electrons and lack of uniform velocity of electrons in the primary electron stream, which necessitate additive corrections ranging from 30 to 50 %; (3) warming of the gas by the filament, necessitating an additive correction of 12 %. Correction to authors' results [see Abstract 590 (1926)].—Owing to lack of uniformity of velocities of electrons in the primary electron stream, we must add corrections of 24 % at 45 volts, 11 % at 100 volts and 9 % beyond 125 volts. With these corrections the results from these two sets of experiments are in fair agreement. Curves show the final values for the probability that an ionising collision will be made in a cm. path in the gas at 0·01 mm. pressure and 25° C. by an electron of any speed up to 400 volts in He, Ne, A, $H_2$, $N_2$, Hg, HCl, and also for the probabilities of ionisation at an impact in these gases. AUTHORS.

**2175.** *Ionisation of Oxygen by Electron Impact as interpreted by Positive-Ray Analysis.* **T. R. Hogness** and **E. G. Lunn.** (Phys. Rev. 27. pp. 732–738, June, 1926.)—Using an apparatus previously described, in which ions formed by impact of electrons of definite energy are analysed by Dempster's positive-ray method, the relative numbers of $0_1^+$ and $0_2^+$ are measured at different pressures and electron energies. Over a range of pressure from $< 10^{-5}$ to $10^{-2}$ mm. of mercury in pure oxygen, and over a large range of partial pressures of oxygen in mixtures with helium and with argon, the ratio $0_2^+/0_1^+$ remains practically constant. Evidence is thus given that $0_2^+$ and $0_1^+$ are formed by independent primary processes and, therefore, that an impact electron of sufficient energy can either ionise the molecule and form $0_2^+$ or dissociate the molecule forming $0_1^+$. The ionisation potentials were determined: $0_2 = 0_2^+ + \epsilon$; 13 volts and $0_2 = 0_1^+ + 0 + \epsilon$; 20 volts. The latter, together with the ionising potential of atomic oxgyen, gives 6·5 volts (150,000 cal. per mol.) for the heat of dissociation of oxygen. Both molecular and atomic negative ions were found. The above results are correlated with band-spectra data, with the recent theory of Franck on dissociation by absorption of radiation, and with the structure of the oxygen molecule. AUTHORS.

**2176.** *Analysis of Positive Ions emitted by a New Source.* **H. A. Barton, G. P. Harnwell** and **C. H. Kunsman.** (Phys. Rev. 27. pp. 739–746, June, 1926.)—Certain iron oxide crystals containing about 1 % of some alkali metal or alkaline earth have been developed by the Fixed Nitrogen Research Laboratory for use as catalysts in the synthesis of ammonia. It has been found that these substances also have great experimental utility as constant and abundant emitters of positive ions. The writers have tested various methods of mounting and heating these emitters. They have also analysed their emission by the use of a mass spectrograph which has been described by Smyth. Separate catalyst samples containing respectively Na, K, Rb, Cs, Mg, Ca, and in one case both Ba and Sr have been shown in this way to emit only the corresponding singly charged positive ion. No doubly charged ions were observed, nor any ions of the other elements composing the catalysts. The alkali metal ions were emitted at lower temperatures than the alkaline earth ions. Particularly in the case of the latter, a preliminary treatment consisting of reduction at red-heat in an atmosphere of hydrogen increased the emission. Emission from hot platinum was also observed consisting of $Na^+$ and $K^+$ ions. This was a surface effect, and diminished rapidly with time. AUTHORS.

**2177.** *Ionisation of Air by X-Rays and Kathode-Rays.* **H. Kulenkampff.** (Ann. d. Physik, 80. 3. pp. 261–278, June 2, 1926.)—There is now no doubt that the ionisation is indirect. The Wilson photographs [see Abstract 2213 (1923)] put this beyond dispute. Since, then, the first effect is the production of photo-electrons, it is to be expected that X-rays and kathode-rays of the same energy would have equal ionising effects. The ionisation by X-rays has already been studied extensively by the author [see Abstract 1357 (1926)]. The effect of kathode-rays has not been so far studied directly but can be obtained from the known ionisation per centimetre of path if the mean path in air is known. The ionisation calculated in relation to the velocity not in agreement with the corresponding results for X-rays. But good agreement can be obtained if one assumes that the absorption is not, as Lenard assumes, a sudden reduction of velocity to nearly zero, but is due to a diffusion effect, the path of the kathode-ray electrons being limited by a gradual loss of velocity. J. E.

**2178.** *Spark Lag with Tension Shocks of Very Short Duration.* **O. Burawoy.** (Archiv f. Elektrot. 16. pp. 186–219, June 14, 1926.)—A method is here given of producing tension shocks of very short duration and determined form by means of wander wave crests. A special arrangement is described for generating very steep crests and shocks. With active ball electrodes no lag appears with sine-formed tension shocks up to a duration of tension mounting from 0 to the max. $t = 3 \cdot 5 \times 10^{-9}$ sec. Also moisture causes no lag with active electrodes. With a homogeneous electric field a lag appears only in consequence of the electrode surfaces becoming dirty. This can be stopped by radiating with radium or arc-light. With point electrodes and tension shocks of very short duration a lag is always present. Neither the condition of the surfaces nor a radiation has any influence on the shock spark tension at great distances of the electrodes. A relationship of the shock spark tension on the duration of the tension shock and distance between electrodes is found. By passing through oil the spark tensions are extraordinarily large with tension shocks of very short duration. A theoretical consideration shows that in respect to the action of the condition of the surfaces with ball electrodes not only are the present results in accord with the ionisation theory but that most of the disagreement in earlier works can be explained. For point electrodes the theory propounded by F. W. Peek is established. A. E. G.

**2179.** *Oscillations, especially with Electron Tubes.* **E. Friedländer.** (Archiv f. Elektrot. 16. pp. 273–279, July 1, 1926.)—The experiments which are here described show that all the known arrangements for generating undamped oscillations are also suitable to enforce periodic charge alterations of a single energy storage. The paper is well illustrated with diagrams showing the various experimental arrangements and the results. A. E. G.

**2180.** *Forced Oscillations in Incited Systems.* **F. Ollendorff.** (Archiv f. Elektrot. 16. pp. 280–288, July 1, 1926.)—This is mainly a mathematical paper in which after a brief introduction the following points are discussed: The mathematical problem; integration of the fundamental equation; the oscillation forms; the solutions for constraining force and tremors; the resulting solution; some extensions.
A. E. G.

**2181.** *Kennelly-Heaviside Layer and Radio-Wave Propagation.* **E. O. Hulburt.** (Frank. Inst., J. 201. pp. 597–634, May, 1926.)—The first part of this paper is a reprint of an earlier one in conjunction with A. H. Taylor [see Abstract 1438 (1926)]. Further consequences of the theory there outlined are now considered. The field of a radio-wave receiving antenna placed some distance above the earth is to be regarded as due to three rays, one direct, one refracted downward from the Kennelly-Heaviside layer and an upward ray, this last being the reflection from the earth of some descending ray. The rectangular components of the resultant electric force are expressed in terms of the components of these rays, and it is seen that in general the electric vector traces out an ellipsoid randomly oriented with respect to the axes. The linear Herz oscillator as used by Picard enables the component of the electric force in any direction to be measured. The experimental results of Picard for the variation with distance from the transmitter of the ratio of the vertical to the horizontal component at right angles to the true transmission direction are plotted, and compared with the ratios calculated on the assumption that the earth's surface is (*a*) a perfect conductor, and (*b*) a perfectly transparent dielectric. When allowance is made for all three rays the calculated curves for a perfectly conducting earth agree tolerably well with the observations, at least for distances less than 500 miles. The wave-lengths considered are 40 and 80 metres. The paper concludes with some discussion of the errors in radio-direction bearings arising from downward reflection by the Kennelly-Heaviside layer. These errors are significant when the downward rays descend at angles greater than about 20° to the horizontal. Thus close to and very far from the transmitter these errors will be slight for all wave-lengths, a result in general accord with observation. W. S. S.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**2182.** *Hall-Effect in Bismuth with Low Magnetic Fields.* **P. H. Craig.** (Phys. Rev. 27. pp. 772–778, June, 1926.)—The Hall-effect in bismuth for a magnetic field strength of from 0·07 to 1·00 gauss was accurately determined by improved methods. For obtaining excessively thin, homogeneous bismuth films, various methods were tried and compared, such as casting, electroplating, evaporating, sputtering and metallic spraying, of which the last three methods were particularly successful. By refinements made in the potentiometer and measuring circuits, readings to one-tenth microvolt were accurate and reproducible. The value of the Hall coefficient, R, is abnormally large between 0·07 and 0·30 gauss, having a value of — 171 at 0·07 gauss, as compared with a value of — 11 which R had for this film at 15 gausses. The value at 4220 gausses was — 29. A curve is plotted showing the rapid decrease in the value of $-$R between 0·07 and 0·30 gauss, and comparison is made with the higher values of field strength. It is noted that by putting the Hall potential of one film in series with one or more other films we obtain comparatively high values of the Hall e.m.f. which may be applied to great advantage as an alternating-current rectifier in radio and similar applications. AUTHOR.

**2183.** *Hall-Effect in Metal Films.* **H. B. Peacock.** (Phys. Rev. 27. pp. 474–483, April, 1926.)—Films of iron cobalt and nickel show Hall coefficients 1·4, 4·9 and 7·8 times, and resistivities 3·1, 23·0, 25·0 times the values for the same metals in bulk, these ratios being in the order of these elements in the periodic table. With the paramagnetic metals palladium and platinum the corresponding figures are 0·66, 0·64 times for Hall coefficients, and 4·4, 14·0 times for resistivities. Heating the films of the ferromagnetic elements decreases the values of the Hall coefficients and of resistivities to approximately those of the metals in bulk. No effect of heating is observed in the case of the paramagnetic metals. The interpretation of these and other results is discussed. G. A. S.

**2184.** *New Evidence in Favour of a Dual Theory of Metallic Conduction.* **E. H. Hall.** (Nat. Acad. Sci., Proc. 12. pp. 326–328, May, 1926.)—Bridgman [see Abstract 318 (1926)] discovered a Peltier development of heat where an electric current changes direction within a crystal, and remarked that the mere existence of an internal Peltier heat would seem to have important bearings on our views of the nature of electrical conduction. The author points out that a formula which he published some years ago as the dual-theory expression for Peltier heat gives a ready explanation of the phenomena observed by Bridgman. The formula is $\pi_{\alpha\beta} = (k_f/k)_\beta \cdot \lambda_\beta - (k_f/k)_\alpha \lambda_\alpha$, where $\pi_{\alpha\beta}$ is the amount of heat in ergs absorbed by the unit quantity of electricity, $1 \div e$ electrons, in going from metal $\alpha$ to metal $\beta$; $k_f/k$ is the ratio of the free-electron conductivity to total conductivity; $\lambda_\alpha$ the amount of heat absorbed in freeing $1 \div e$ electrons within metal $\alpha$, and $\lambda_\beta$ within metal $\beta$. Within a single metal crystal $\alpha$ and $\beta$ refer merely to different directions of current flow, and $\lambda_\alpha = \lambda_\beta$. Thus the formula reduces to $\pi_{\alpha\beta} = [(k_f \div k)_\beta - (k_f \div k)_\alpha] \cdot \lambda$, where $\lambda$ when expanded is $\lambda = (\lambda'_c + s\mathrm{RT}) \div e$, the quantity in brackets being the amount of energy required to change one electron from the associated conductive state to the free conductive state, and $\lambda'_c$ and $s$ are constants. T. B.

**2185.** *Disturbances of Supra-conductivity.* **W. Tuyn** and **H. K. Onnes.** (Phys. Lab. Leiden, Comm. No. 174A. Frank. Inst., J. 201. pp. 379–410, April, 1926.)—The disturbances of supra-conductivity by raising the current density and by the presence of a magnetic field are here investigated for lead, tin and indium wires wound in different ways and for a tin cylinder. The results support the hypothesis of Silsbee that the current operates not as a separate disturbing factor, but in virtue of the magnetic field it itself produces. G. A. S.

**2186.** *Continuous Currents in Super-conductors.* **E. Kretschmann.** (Ann. d. Physik, 80. 2. pp. 109–136, May 27, 1926.)—Points out difficulties in accepting the conclusion of K. Onnes that the conductive electrons are restricted at low temperatures to fixed paths from atom to atom, from which external magnetic forces cannot dislodge them. Works out a theory *ab initio* on the assumption that a proportion or the whole of the electrons within the metal are free. Shows (1) how super-conductivity may arise; (2) how electric resistance occurs, with a simple resistance formula; (3) how conduction in super-conducting lead may be calculated; (4) the theory of a super-conducting hollow lead sphere in a magnetic field; (5) why the Hall-effect disappears. A. D.

**2187.** *Conductivity and Catalytic Action of the Halogen Hydracids in n-Butyl Alcohol.* **H. Goldschmidt** and **E. Mathiesen.** (Zeits. phys. Chem. 121. pp. 153–158, May 24, 1926.)—Just as is the case in methyl and ethyl alcohols [see Abstract 931 (1925)], hydrogen chloride, bromide, and iodide exhibit unequal conductivities in absolute *n*-butyl alcohol solutions. Gradual addition of water to the hydrogen chloride solution causes at first a diminution and later an increase in the conductivity. As regards the catalytic actions of the three acids on the esterification of phenylacetic acid in *n*-butyl alcohol, those of hydrogen bromide and iodide are about equal and somewhat greater than that of hydrogen chloride. T. H. P.

**2188.** *Factors Influencing the Accuracy of Measurements of the Electrical Conductance of Liquids and Solutions. II. Bridge Assembly, with particular Reference to the Vreeland Oscillator as a Source of Current of Constant Frequency.* **J. L. R. Morgan** and **O. M. Lammert.** (Am. Chem. Soc., J. 48. pp. 1220–1233, May, 1926.)—The frequency of a Type A Vreeland oscillator giving 1000 cycles was found to decrease by 1 % during a day's work, finally becoming constant. The magnitude of this change appears to depend on decrease in the capacity and inductance in the primary resonating circuit caused by the heating effect of the current and to be independent of the angle of coupling, the relative positions of the primary and secondary coils, if these are not too close, the load on the secondary, or, except for slight dependence of the initial frequency supplied with a certain setting of the capacity, of the room-temperature. Three oscillators of type D were found to differ, on starting, from their rated 500 frequencies by 0 to 4 %, and to show at first decrease, then increase, and finally constancy of frequency. Resistance coils (1000 ohms) of the Curtis type were found to vary, during three years, by about 0·5 % of the nominal value, the coils being at least a year old before the first calibration; periodic recalibration of such coils is hence necessary. Of two roller-type Wheatstone bridges, one gave results agreeing to within 0·002 % with those obtained with direct current, whereas the other gave results inaccurate to the extent of 1 %. Methods of shielding and earthing the apparatus are discussed [see Abstract 2271 (1923).] T. H. P.

**2189.** *Dielectric Constants of Benzene Solutions.* **J. R. Partington** and **J. F. J. Rule.** (Phil. Mag. 1. pp. 1035–1039, May, 1926.)—The dielectric constants of *m*-dinitrobenzene, phenol and benzoic acid in benzene are determined by the Nernst method as modified by Turner. With *m*-dinitrobenzene and phenol the values increase steadily with concentration and appear to approach the value for the pure solute in the fused state. With benzoic acid the dielectric constant increases with concentration to a maximum and then decreases. [See also Abstract 2758 (1925).] J. N. P.

**2190.** *Test for Space Quantisation in a Magnetic Field.* **B. B. Weatherby** and **A. Wolf.** (Phys. Rev. 27. pp. 769–772, June, 1926.)—The heterodyne beat method was used to detect a possible change in the dielectric constant of gases, due to space quantisation in a magnetic field. A condenser, forming a part of one oscillating circuit of about 1,000,000 cycles frequency, was filled with the gas investigated and the magnetic field then applied. The results obtained show that for helium (20-cm. pressure), air (76 cm.) and oxygen (76 cm.) at room-temperature there is no change in the dielectric constant to 1 part in 500,000. The magnetic field was of the order of 7000–8000 gausses, while the electric field was estimated at 5000–10,000 volts/cm. The tests were carried out with the direction of the electric field both parallel and normal to the direction of the magnetic field. AUTHOR.

**2191.** *Investigation of Metallic Crystals. IV. Thermoelectric Properties of Zinc and Cadmium.* **E. Grüneisen** and **E. Goens.** (Zeits. f. Physik, 37. 4–5. pp. 278–291, 1926. From the Reichsanstalt.)—Rods formed of monocrystals were employed, the direction of the axes having previously been determined. A piece of pure copper wire was soldered to each end of these, and they were placed, in turn, vertically with the lower end in a liquid bath kept at constant temperatures ranging from − 253° C. up to 100° C., while the temperature of the upper end was also kept constant. Curves are given showing the thermo-electromotive force E for various temperature differences between copper and rods in which the crystal axes were parallel and perpendicular to the axes of the rods, and from these curves were constructed giving E for the junction between two rods of the same metal, Zn or Cd, one with its axis $\perp$ and the other $\|$ to its length. Assuming that the Kelvin equations hold, the authors deduce the Peltier-effects and the Thomson coefficient differences; the relations of these and of $e = \frac{dE}{dt}$ to the temperature make it possible to recognise regularities, and in particular a connection with the frequency of the atomic vibrations of the metals, though so far it is not possible to express this by means of a formula. H. N. A.

**2192.** *Linear Amplification of Galvanometer Deflection by the Photoelectric Cell.* **F. E. Null.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 521–522, May, 1926.)

**2193.** *Galvanometer Coil with Maximum Sensitivity.* **T. Ikebe.** (Imp. Acad. Tokyo, Proc. 2. pp. 163–168, April, 1926. In English.)—Maxwell has given a curve for the best form of galvanometer coil giving maximum axial magnetic force at the centre of the magnet needle, and Ayrton, Mather and Sumpner have pointed out that with a needle of finite length some of the possible turns near the centre will produce an opposing force at the magnet poles. The author introduces a quantity S, such that S/σ may be called the volt-sensitivity of a turn of the coil, where $\sigma$ is the resistance of the conductor per unit of length, and determines curves for which S has a series of fixed values. The curve for which $S = O$ corresponds to that obtained by Ayrton, Mather and Sumpner by a graphical method. In turns for which S has a negative value the direction of the current must be reversed. H. N. A.

**2194.** *Accessory to the Kathode-Ray Oscillograph for Changing Oscillograms from a Sinusoidal to a Linear Time Base.* **C. F. Wiebusch.** (Journ. Sci. Instruments, 3. pp. 249–252, May, 1926.)—An instrument is described which will convert an oscillogram, taken wlih a kathode-ray oscillograph and using a sinusoidal reference deflecting field, into an oscillogram having a linear time base. AUTHOR.

**2195.** *A Kathode-Ray Oscillograph for Several Simultaneous Waves with Stabilised Linear Time Axis.* **F. Bedell** and **H. J. Reich.** (Science, 63. p. 619, June 18, 1926.)—A linear time axis for the kathode-ray oscillograph is obtained by repeatedly charging a condenser through a saturated thermionic rectifier and discharging through a neon lamp when a critical voltage is reached. The period (controlled by condenser capacity and rectifier filament current) can be made approximately synchronous with periodic phenomena under study, so that the oscillograph shows a nearly stationary wave in rectangular coordinates. For the study of alternating currents precise synchronism is obtained by introducing some of the alternating current into the neon circuit, thus synchronising the discharge of the condenser and giving an absolutely stationary alternating-current wave. Two or more waves can be obtained simultaneously by a motor-driven switch making connection to the several sources rapidly in succession. AUTHORS.

## ALTERNATING CURRENTS AND MAGNETISM.

**2196.** *The Wave Form of the Current in an Electrically-maintained Tuning-fork Circuit.* **V. H. L. Searle.** (Phil. Mag. 1. pp. 738–747, April, 1926.)—The performances of a "solid contact" and a "mercury-platinum" form of contact for maintaining the oscillations of a tuning-fork are compared by means of their respective current-wave forms determined by an oscillograph. The former acts irregularly, whilst the latter, in which a platinum wire fixed to the fork prong dips into and is withdrawn from mercury, is very regular. Capacity across the spark-gap reduces the current amplitude and affects the shape of the current wave. Inductance does not affect the wave form, but renders maintenance more difficult. The variation of the mercury arc resistance with time and arc length is determined by Fourier analysis of the wave-current form. J. S. G. T.

**2197.** *Hysteresis.* **P. Straneo.** (Accad. Lincei, Atti, 3. pp. 316–321, March 21, 1926.)—Discusses the genesis of hysteretic cycles, discriminating between the cases where the residual condition is evanescent and those where it is not. A. D.

**2198.** *Foundations of Geometry applied to Alternating Currents.* **G. Rimini.** (Elettrotecnica, 13. pp. 274–280, May 5; 297–304, May 15;

321–326, May 25; 345–353, June 5; 369–380, June 15, and pp. 393–401, June 25, 1926.)—The author's object is to arrange and coordinate the copious material available showing the application of geometry to electrotechnics. The articles are illustrated with numerous diagrams and are entirely mathematical. E. F.

**2199.** *Effect of Pressure on the Susceptibility of Diamagnetic Gases.* **E. Lehrer.** (Zeits. f. Physik, 37. 1–2. pp. 155–156, 1926.)—The gases $CO_2$ and argon were contained in a horizontal tube and subjected to a strong transverse magnetic field. A difference of pressure $\Delta p$ between the ends of the tube was produced by electrical heating, and was measured by means of a Heis manometer [see Abstract 2882 (1924)]. It is shown by graphs that with constant difference of temperature $(T_1 - T_2)$ $\Delta p$ is proportional to $p$, and with constant pressure $\Delta p$ is proportional to $\frac{1}{T_1} - \frac{1}{T_2}$. The specific susceptibilities $\chi$ were determined; their values were: $\chi CO_2 = -0{\cdot}47 \times 10^{-6}$; $\chi Ar = -0{\cdot}50 \times 10^{-6}$. Contrary to Glaser's result [see Abstract 1122 (1926)], $\chi$ is found to be independent of the pressure. G. E. A.

**2200.** *Orientation of the Oxygen Molecule in a Magnetic Field.* **L. C. Jackson.** (Phil. Mag. 1. pp. 1193–1198, May, 1926.)—The theory of space quantisation has been confirmed experimentally by Gerlach and Stern [Abstract 1494 (1925)], the separation obtained between the two streams of atoms of silver being a fraction of a millimetre. Theoretically, oxygen should give a much greater separation. This was tested by causing a jet of oxygen to pass through a non-homogeneous magnetic field and then to impinge on a soap-film, of which an enlarged image was produced by an arc-lamp and screen. In whatever way the conditions were modified, in no case was any change in the form of the point of impact of the jet on the film observable. The probable interpretation of the experiment is that the oxygen molecule can, after collision, take up any one of the possible quantum orientations, passing eventually through them all. G. E. A.

**2201.** *The Electronic Theory of Thermomagnetic Phenomena.* **O. M. Corbino.** (Accad. Lincei, Atti, 3. pp. 250–256, March 7, 1926.)—Continuation of previous paper [see Abstract 1462 (1926)]. The mathematical results may be thus summarised: (1) The Lorentz-Gans theory applied to a disc traversed by a radial centrifugal current of heat or electricity foresees the formation of a circular thermomagnetic or galvanomagnetic current identical in direction with that which produces the magnetic field. For either current this is contrary to the truth in the case of all metals, including bismuth, with the sole exception of gold, silver and copper. (2) The Livens theory would in some cases permit the elimination of the contradiction, but the law of distribution of velocities on which it rests is in conflict with the laws of electromagnetism, since it involves the existence of a thermal analogy of Barlow's wheel. E. F.

**2202.** *Magnetic Field of an Electromagnet with Bored Pole-pieces.* **H. Nagaoka and K. Uchiyama.** (Imp. Acad. Tokyo, Proc. 2. pp. 158–160, April, 1926. In English.)—The magnetic fluxmeter used consisted of a rectangular coil suspended by a bifilar suspension of two thin Cu wires and placed between the pole-pieces of an electromagnet. The characteristic feature is the smallness of the coil, which can be in a square form of 1 mm. edge, and optical arrangements of the highest sensitivity are required for the experiments. Exploration of the field between the poles of the electromagnet shows that the field is not uniform. Along the axis a minimum exists at the centre and increases towards the poles. Perpendicular to the axis there is a maximum at the centre, and the field decreases outwards. With bored pole-pieces there is again a different volume magnetisation at different parts. As the volume density of free magnetism depends on the gradient of the permeability of the iron core used in constructing the electromagnet, the problem of finding the best form of the pole-pieces is not easy, and at present empirical methods are necessary. R. S. R.

**2203.** *The Magnetic Perturbation and Aurora of April* 14, 1926. **F. Baldet, V. Burson** and **H. Grenat.** (Comptes Rendus, 182. pp. 962–963, April 19, 1926.)—At Meudon Observatory, on April 14, 14 h., the magnetograph bells, responding only to large deviations of the magnetic needle, were heard not only in the spectroheliograph building, but also in the physical laboratory 400 m. away. Some good photographs were obtained of the four solar layers. At night auroræ were looked for, and at 20 h. 52 m., when the moon set, vertical auroral rays of a whitish tint and of considerable intensity were seen against the western sky, while more to the left was seen another smaller vertical aurora, gradually dissolving into the first one, rising to an altitude of 30° to 35°. But the whole phenomenon, first seen at 14 h., was over in about 45 seconds, and simultaneously the magnetic needle swung strongly towards the east. At 25 minutes after midnight there was another strong swing to the east, but the observers had left, so did not know if there was a repetition of brief auroral display. Watch began again at 1 h. until dawn, but nothing abnormal happened. G. W. de T.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

**2204.** *Absorption of Gases by Activated Charcoal at Very Low Pressures.* **H. Rowe.** (Phil. Mag. 1, pp. 1042–1054, May, 1926.)—The adsorption isotherms for nitrogen, hydrogen and carbon monoxide on charcoal are determined at very low pressures and a temperature of — 182° C. Curves giving the relation between the adsorption and pressure are linear up to a certain critical pressure. This critical pressure is comparatively high for gases of low boiling-point and considerably lower for gases of high boiling-point, which are more readily adsorbed. The isotherms have the same characteristics as those at higher pressures and are better represented by the equation $\log_{10}\frac{\alpha}{p} = A_0 - A_1\alpha$ than by $\alpha = kP^{1/n}$, where $\alpha$ = number of c.c. at N.T.P. adsorbed per gm. of charcoal, P = pressure in cm. of mercury. $A_0$, $A_1$, $k$ and $1/n$ are constants depending on the particular gas. The connection between $\alpha$ and P departs from a linear relationship after the active surface of the charcoal has been covered with a layer of unit molecular depth. [See also Abstract 1480 (1926).] J. N. P.

**2205.** *Adsorption of Soap Solutions.* **R. Dubrisay.** (Comptes Rendus, 182. pp. 1217–1219, May 17, 1926.)—The adsorption of soap solutions on a benzene surface is measured by a method devised by Lewis and Donnan [see Abstract 269 (1912)], and consists in allowing a known volume of benzene to issue from a narrow capillary into the base of a column of the soap solution and to pass through the solution in the form of drops. The concentration of the solution is estimated from its effect on surface-tension by determining the size of the drops, and the change of concentration through adsorption is noted. It is found that the presence of electrolytes causes a marked increase in the adsorption of the soap in accordance with their effect in diminishing the solubility of the soap. [See also Abstract 1340 (1924).] J. N. P.

**2206.** *Water as Surface-active Material. Surface Activity and Forces of Adsorption. II.* **P. Rehbinder.** (Zeits. phys. Chem. 121. pp. 103–126, May 23, 1916.)—The surface-tension $\sigma$ of pure water is slightly raised by the presence of aqueous solutions of certain inorganic salts, which the author calls surface-inactive. Extending his studies of solutions of organic compounds [see Abstract 3071 (1924)] to solutions of inorganic salts of all concentrations $c$ up to saturation, the author finds that the $\sigma$ deducted by extrapolation for the pure salt (*i.e.* the $\sigma$ which the fused salt would have if it could be undercooled to the temperature of observation) is much smaller than the observed value. The salts examined, partly near 100° C., are the nitrates of silver, of silver-ammonium and of silver-thallium, potassium nitrite and potassium carbonate. The surface layers of such solutions may be unsaturated (active layer) or saturated (inactive layer); some estimates are made of the thickness (a few molecules) of the surface layer. The curve $\sigma/c$ consists of an active and an inactive portion. Of the two components of such solutions, solvent and salt, the active one has the smaller dielectric constant.

Water is surface-active in the salt solutions mentioned, but inactive, *e.g.*, in solution of butyric acid, the dielectric constants being water 81, butyric acid 3. H. B.

**2207.** *Adsorption Experiments with RaD and RaE.* **J. P. McHutchison.** (Roy. Soc., Proc. 111. pp. 134–143, May 1, 1926.)—The author summarises as follows: "Previously known facts regarding the adsorption of a single radio-element from its solution, either by a precipitate formed in the solution or by an added solid, are in general found to hold for the simultaneous adsorption of the two radio-elements, RaD and RaE, when present in radio-active equilibrium. It is pointed out, however, that the results in several cases are influenced by abnormal adsorption effects. Isotopic precipitates possess no greater adsorptive powers than certain non-isotopic precipitates, which can completely carry down the radio elements. An isotopic precipitate formed under such conditions that one of the two analogous radio-active compounds is soluble, exhibits a preference for its own isotope, whereas a non-isotopic precipitate displays no such preference. The addition of a soluble lead salt to a solution of RaD and RaE stops the adsorption of RaD by charcoal, and in this way RaE has been extracted in a state of great purity. The half-life period of RaE has been found to be 4·9 days." A. B. W.

**2208.** *Chemical and Physical Action at Surfaces.* **E. K. Rideal.** (Nature, 117. pp. 626–628, May 1, 1926. Paper read before the Royal Inst., Feb., 1926.)—The relation between catalysis and surface adsorption and structure is discussed. The field of force which contributes to the adhesional potential energy of the surface is affected both by the interatomic distance as well as by the number and variety of atoms around one particular atom. Catalytic action appears to be limited to the primary adsorbed film, those portions which are unstable and readily adsorb gases are also catalytically active. The different types of active surfaces which can occur on nickel are enumerated with instances of the different specific chemical actions that can be brought about. With carbon containing both iron and nickel there exist areas of different active complexes which possess different specific surface activities and different temperature coefficients for the reaction velocities. Reference is made to evidence which shows that there exists an intimate connection between the catalytic activity of a metal and the thermionic emission. J. N. P.

**2209.** *Properties of Chloride Solutions and Mixtures.* **C. E. Ruby** and **J. Kawai.** (Am. Chem. Soc., J. 48. pp. 1119–1128, May, 1926.)—A systematic investigation of the conductivities of solutions of pairs of uni-univalent electrolytes having a common ion was made, in the hope of disclosing the nature of the solutions, and to test the value of the methods of calculating the conductances of solutions of such mixtures of electrolytes. The densities, equivalent conductance, and relative viscosities at 25° C. of a series of solutions of hydrochloric acid, potassium chloride, sodium chloride, and of a series of their binary and ternary mixtures were determined and the results tabulated. The equivalent conductance of the mixtures of these electrolytes can be fairly well represented by a straight line relation, although the differences between the measured values and those computed by the rule of mixtures amounts in some cases to more than 7 %. F. J. B.

**2210.** *Solubilities of Potassium Haloids in Alcohol-Water Mixtures.* **S. M. Zeitlin** and **A. E. Brodsky.** (Zeits. phys. Chem. 121. pp. 39–45, May 24, 1926.)—The results are given of determinations of the solubility of potassium chloride, bromide and iodide in 25·96, 45·13, 74·88, and 100 % (by weight) methyl alcohol solutions and in 25·07, 50·01, 75·03, and 97·30 % ethyl alcohol solutions at 10·2° and 19·9°. The results are in moderately good agreement with Walden's rule, namely, $D : \sqrt[3]{L} = \text{constant}$, L being the solubility and D the dielectric constant of the solvent. T. H. P.

**2211.** *Constitution of Magnesium Acetate Solutions.* **A. C. D. Rivett.** (Chem. Soc., J. pp. 1063–1070, May, 1926.)—Experiments in the preparation of hydrated magnesium acetate from magnesium oxide, acetic acid and water to bring to light the proneness to form super-saturated solutions, the slowness with which these crystallise after seeding, and the very high viscosities of solutions above a certain range of concentration. No simple equation connects the viscosity at 25° with the concentration. Rapid rise in viscosity begins at about 2·5 gm.-mols. of the salt per 1000 gm. of water ($M_w$), the value relative to water as unity increasing from about 7 at that concentration to 155 for $M_w = 5 \cdot 4$ (supersaturated). The evidence is against the view that this great change in viscosity is due to hydration of the salt, and the suggestion is made that, in the passage from relatively dilute solutions in which ionic dissociation is considerable, there is increasing tendency for association of molecules to occur, such association being the result of chelate ring-formation by the magnesium atom exercising a coordination number of 4 towards oxygen atoms. T. H. P.

**2212.** *Preparation of Nickel Membranes for Ultra-filtration.* **J. Manning.** (Chem. Soc., J. pp. 1127–1132, May, 1926.)—The ordinary membranes used for ultra-filtration are prepared by impregnating filter-papers with nitrocellulose dissolved in acetic acid or in a mixture of ether and alcohol, and cannot be used either at high temperatures or with solvents such as acetone. Membranes made by nickel plating on bronze or nickel gauze are found to be capable of retaining most colloids on ultra-filtration, and may be used at high temperatures and with solvents which attack the ordinary membranes. The average size of the pores may be controlled by varying the plating bath, application of these membranes to fractional filtration being thus rendered possible. T. H. P.

**2213.** *Complexity of Tempering Phenomena of Certain Alloys.* **A. Portevin** and **P. Chevenard.** (Comptes Rendus, 182. pp. 1143–1145, May 10, 1926.)—A further study of the tempering of the alloys Al-$Mg_2$Si Al-$Al_2$Cu in comparison with that of steel [see Abstract 1155 (1923)]. This has revealed in aluminium bronze (12 % Al) the existence of a labile state of low density in addition to the $\gamma$-form, which is stable at high temperatures, and the $\alpha$-form, which is stable at low temperatures. T. M. L.

**2214.** *Cementation of Alloys of Iron and Copper by Tungsten, Molybdenum, and Tantalum.* **J. Laissus.** (Comptes Rendus, 182. pp. 1152–1154, May 10, 1926.)—The author had previously studied the cementation of iron alloys by chromium and tungsten [Abstract 2386 (1925)] and the investigation was extended to the cementation of these alloys and of brass by molybdenum and tantalum. The extent of cementation was determined by measuring the depth of penetration seen in the microsections. The effect of temperature was investigated for 800, 900, 1000, 1100, and 1200° C., and the times of heating varied from 2½ to 10 hours. The investigation is being carried further to examine the influence of the cementation on corrosion of the alloy. F. J. B.

**2215.** *Tempering of Aluminium Alloys after Quenching.* **W. Fraenkel.** (Zeits. f. Metallkunde, 18. pp. 189–192, June, 1926.)—The experiments relate to alloys of the duralumin type. The changes going forward after quenching are examined by measurements of changes in electrical resistance. Some tentative views are advanced as to the cause of the observed effects. [See also Abstract 630 (1926).] A. A. D.

**2216.** *What is a Metal?* **A. Eucken.** (Zeits. f. Metallkunde, 18. pp. 182–188, June, 1926.)—High electrical conductivity appears to be the most characteristic property of metals. The relations between this property and others, such as thermal conductivity and reflection power are considered from both experimental and theoretical viewpoints. Finally all the metallic properties are regarded as due to the presence of practically free electrons. The paper contains no new results, being merely a summary of modern views upon the atomic structure of metals. A. A. D.

**2217.** *Influence of Kathodic Hydrogen on the Tenacity of Steel.* **D. Alexejew** and **M. Polukarow.** (Zeits. Elektrochem. 32. pp. 248–252, May, 1926.)—A steel wire subjected to kathodic polarisation in pure sodium hydroxide or sulphuric acid solution retains its elasticity unchanged. When, however, a small amount of mercury or arsenic is added to the electrolyte, the wire becomes brittle, its tensile strength being diminished to one-twentieth of its original value. The phenomenon is shown to be highly complicated, and the penetration of the hydrogen into the steel is discussed in relation to the supertension and to the intermediate formation of the hydride at the kathode. T. H. P.

**2218.** *High-temperature Oxidation of Metals.* **J. S. Dunn.** (Roy. Soc., Proc. 111. pp. 203–209, May 1, 1926.)—The oxidation of three brasses containing respectively 95 %, 90 % and 71 % Cu, at temperatures ranging from 580° C. to 880° C., is investigated quantitatively and is found to be controlled by diffusion through a protective film of oxide, the rate of oxidation varying exponentially with the temperature. A theory of diffusion in solid solutions is outlined, and by the application of statistical laws to the thermal agitation of solids, an expression which is in formal agreement with the experimental law is deduced for the variation of diffusion rate with temperature. A. B. C. L.

**2219.** *Low-temperature Oxidation of Copper.* **J. S. Dunn.** (Roy. Soc., Proc. 111. pp. 210–219, May 1, 1926.)—The oxidation of Cu of normal commercial quality at temperatures between 200° C. and 300° C. is studied and is found to follow the theoretical parabolic law over comparatively short time intervals. With catalytically active Cu, however, the parabolic law is not obeyed, oxidation proceeding more rapidly than with normal Cu. The origin of this departure from the ideal law is traced to changes occurring in the oxide film, and a general parallel is established between catalytic behaviour and oxidation rate. A. B. C. L.

**2220.** *A New Method for the Production of Herapathite.* **A. Zimmern.** (Comptes Rendus, 182. pp. 1082–1083, May 3, 1926.)—Certain complex organic crystalline compounds have been found which polarise light similarly to spar and tourmaline, *e.g.* the sulphate of iodo-quinine discovered by Herapath, which is obtained by admixing a hot alcoholic solution of iodine with an aceto-alcoholic solution of neutral sulphate of quinine, when on cooling fine rectangular lamellar crystals appear at the liquid surface which exhibit a remarkable dichroism in thin layers. Prepared by the original method, these crystals are useless for optical purposes, but a process is now described wherein the quinine solution is treated with iodine vapour and crystals of a suitable thickness are obtained. Brief experimental details are included, together with a description of the utility of the substance. H. H. Ho.

**2221.** *Production of Polarising Surfaces by Deposition of Herapathite upon Vertical Plates.* **A. Zimmern and M. Coutin.** (Comptes Rendus, 182. pp. 1214–1215, May 17, 1926.)—In a previous paper [see preceding Abstract] Zimmern has shown how to prepare suitable surfaces of herapathite by a vapour method which secures the homogeneity and initial orientation of the crystalline separation. The results are now found to be even better if the deposition is made upon vertical plates, and this paper contains a detailed description of the process. The plates so obtained hold a transparent layer of crystalline herapathite of about 5 mm. depth, which can be removed and utilised in the construction of opera-glasses, microscopes, telescopes, etc., and generally for optical instruments of large aperture. The method itself is recommended for the synthetic production of suitable minerals. H. H. Ho.

**2222.** *Chemical Statics of Electronic Phenomena.* **L. Rolla and G. Piccardi.** (Accad. Lincei, Atti, 3. pp. 410–413, April 11, 1926.)—The ionisation potentials of lanthanum, cerium, praseodymium, neodymium, and samarium are determined by a method similar to that described in earlier papers [Abstracts 152 and 889 (1926)]. A higher temperature than can be obtained in a Bunsen flame is necessary, and a burner is used fed with gas and oxygen with careful manometric adjustments. Consequently rearrangements of the experimental apparatus have to be made, and iridium is used for the grid. The values obtained are: La, 5·49; Ce, 6·91; Pr, 5·76; Nd, 6·31; Sa, 6·55. [See next Abstract.] A. Wh.

**2223.** *Chemical Statics of Electronic Phenomena.* **G. Piccardi.** (Accad. Lincei, Atti, 3. pp. 413–416, April 11, 1926.)—If neutral atoms with an affinity for electrons are present in a flame in which measurements of an ionisation potential are being made [see preceding Abstract], the current measured will be reduced. The affinity of atomic iodine for electrons is measured in this way and a mean value 3·58 volts is obtained. This corresponds to 82,000 cals. and agrees with Gerlach and Groman's value, 82,000 cals., and Born's, 81,000 cals. Applying Einstein's formula, the limiting wave-length of the continuous radiation emitted by iodine becomes λ3450, in agreement with experiment. A. Wh.

**2224.** *Transfer of Excited Energy from Ozone to Hydrogen and Nitrogen.* **A. C. Grubb.** (Science, 63. pp. 460–462, April 30, 1926.)—The activation of hydrogen and nitrogen by ozone was examined experimentally. A stream of hydrogen and nitrogen at atmospheric pressure, mixed approximately in the ratio of three to one, was led at a velocity of about eight litres per hour over an anode at which ozone was being evolved at a very rapid rate. The escaping gases were washed in ammonia-free water, which was subsequently tested for any ammonia which had been formed during the passage of the gases over the anode. The duration of the experiments was fifteen minutes, and the absorbing liquid was tested for ammonia by Nessler's solution. The results show that considerable quantities of ammonia are formed, but further work is necessary in order to determine the mechanism of the reaction, which is, however, entirely free from nitrates. F. J. B.

**2225.** *Reaction Velocity and Equilibrium between Mutameric Forms.* **H. v. Euler and I. Hedström.** (Arkiv f. Kem. Min. o. Geologie, Stockholm, 9. 17. [6 pp.], 1926. In German.)—An investigation of the equilibrium between α glucose and β glucose was made. The determinations were carried out at 20 C., and the velocity of the reaction was measured by a polarimeter. The acidity of the solutions was determined by electrometric methods using a hydrogen electrode. The equilibrium constant was determined in the presence of 0·005 *n* citrate solution and hydrochloric acid. It was found that the same value resulted when the starting material was α or β glucose. F. J. B.

**2226.** *A Homogeneous Unimolecular Reaction. Thermal Decomposition of Acetone in the Gaseous State.* **C. N. Hinshelwood** and **W. K. Hutchison.** (Roy. Soc., Proc. 111. pp. 245–257, May 1, 1926.)—The thermal decomposition of acetone in the gaseous state is shown to be a homogeneous unimolecular reaction, since the time taken for any fraction of the total change to be completed is independent of the pressure, and variation of the amount of surface exposed to the gas leaves the reaction velocity unchanged. The heat of activation is 68,500 *k*, the results over the range 506–632° C. being expressed by $\log_e k = 34 \cdot 95 - 68{,}500/\mathrm{RT}$. The number of molecules reacting per second is about $10^5$ times greater than the maximum number that could be activated by collision, the rate at 835° A. being the same as that for the decomposition of nitrogen pentoxide at 328° A. This indicates that some form of radiation theory must be developed to account for these phenomena. B. W. C.

**2227.** *Comparison between Unimolecular and Bimolecular Gaseous Reactions. Thermal Decomposition of Gaseous Acetaldehyde.* **C. N. Hinshelwood** and **W. K. Hutchison.** (Roy. Soc., Proc. 111. pp. 380–385, June 5, 1926.)—The thermal decomposition of acetaldehyde in the gaseous state is shown to be a homogeneous bimolecular reaction over the range 430–592° C., as compared with the decomposition of acetone previously investigated, which is unimolecular [see preceding Abstract]. The rate of reaction can be calculated from the equation $k = 5 \cdot 5 \times 10^{10}\sqrt{\mathrm{T}} \cdot e^{-45{,}500\ \mathrm{RT}}$, *k* being expressed in gramme-molecules per litre per sec. The rate of reaction can be calculated from kinetic considerations, assuming that pairs of molecules react with a minimum joint energy on collision of 45,500 calories, thus showing that for a bimolecular decomposition there is an exact relation between the heat of activation, the number of collisions and the rate of reaction, as predicted by theory, in contrast with a unimolecular decomposition which is independent of the number of collisions. B. W. C.

**2228.** *The Acid-basic Function and Electric Charge Type of Molecules.* **J. N. Brönsted.** (J. Phys. Chem. 30. pp. 777–790, June, 1926.)—The definition of acids A and bases B by the scheme $A \rightleftharpoons B + H^+$ (1) implies that an acid is a substance which splits off $H^+$-ions, simultaneously forming a base, and a base is a substance capable of uniting with $H^+$-ions, thus forming an acid. The unique position of acids and bases is due to the unique properties of the $H^+$-ion and its mobility. When equilibrium (1) is established in water as solvent, the $H^+$ is solvated: $A + H_2O = B + H_3O^+$(2), which is a double acid-base equilibrium, A and $H_3O$ acting as acids, B and $H_2O$ as bases. This conception assigns acid or basic properties to both ions and neutral molecules. When A is acetic acid, B (the base) must be the acetate ion; when B indicates ammonia, A (the acid) must be the ammonium ion; hence the importance of the electric charge. The acid property of positive electric aquo-ions like $Al(H_2O)_6^{+++}$ is the stronger, the higher the positive charge. According to Kossel, the attraction between the $H^+$ and the $Cl^-$ of HCl (single charges) is weaker than it is in $H_2O$ and $H_3N$ (double and triple charges), and HCl is therefore a stronger acid than the others. The author develops the theory of Kossel of the importance of the central atom in complex configurations, and deduces a rule for the acidity and basicity of the molecules of the elements in any of the seven groups of the periodic table. The electrostatic effects tend to make acids with two or more positive charges more strongly ionising in solvents of low dielectric constant than in water. An absolute comparison of the strengths of two acids or bases is impossible, because it would require the absence of a solvent medium. The free $H^+$-ion does not exist. H. B.

**2229.** *The Chemical Action of Gaseous Ions produced by Alpha Particles. VII. Unsaturated Carbon Compounds. VIII. The Catalytic Influence of Ions on Inert Gases.* **S. C. Lind, D. C. Bardwell** and (for VII) **J. H. Perry.** (Am. Chem. Soc., J. 48. pp. 1556–1575 and 1576–1584, June, 1926.)—The same methods are employed as in previous investigations [see Abstract 887 (1926)]. Nine reactions of polymerisation, hydrogenation, or oxidation of the unsaturated compounds, acetylene, cyanogen, hydrogen cyanide, and ethylene have been carried out, and the velocity constants and the ratios (M/N) of molecules reacting per ion pair have been calculated. The first three form solid products: M/N is 19·8 for acetylene, 7·4 for cyanogen, 11·1 for hydrogen cyanide; ethylene eliminates 16 % of its H, condensing to a colourless liquid, M/N = 5·1. Particulars of the hydrogenations and oxidations are given. Inert gases, $N_2$, He, Ne, A, Kr, Xe, $CO_2$, and $H_2$ were found to catalyse a number of the above reactions, the ions of the inerts being quantitatively equal to those of the reactants in producing chemical reaction. Certain exceptions are met with in the case of N and $CO_2$. H. N. A.

**2230.** *Applicability of Wolff's Temperature Formula for the Weston Standard Cell.* **W. C. Vosburgh.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 511–517, May, 1926.)—The author shows how Wolff's formula, derived from a large number of cells with neutral electrolytes, differs appreciably from previously proposed formulæ. After describing the cells and the procedure employed, he gives the results obtained in a table, from which it is gathered that most of the cells showed a small change in electromotive force during the course of the measurements. Although small, these changes should be taken into account in calculating the variation of electromotive force with temperature. An increase of temperature seems to disturb the equilibrium little, if any; but a decrease makes a disturbance which manifests itself as hysteresis in many cells. It can be concluded that for all properly constructed normal Weston cells with either neutral or slightly acid electrolytes calculation by means of Wolff's formula will give the difference between the electromotive force at any temperature between 15° and 40° and that at a standard temperature within about 10 mm.v., or 0·001 % of the electromotive force of a cell. [See Abstract 1680 (1908).] T. C. H.

**2231.** *E.M.F. Measurements with Sulphate Solutions.* **G. Åkerlöf.** (Am. Chem. Soc., J. **48.** pp. 1160–1176, May, 1926.)—The activity coefficients of potassium, sodium and lithium sulphates are calculated from measurements with cells of the type:

$$Hg/Hg_2SO_4/M_2SO_{4(c)}/M_xHg/M_2SO_{4(c_1)}/Hg_2SO_4/Hg.$$

where M is the alkali metal, $c_1$ the reference and $c$ the salt concentration. These results are considered from the point of view of the Debye and Hückel theory. The activity coefficients of sulphuric acid in potassium, sodium and lithium sulphate solutions are calculated from measurements of cells of the type: $H_2/H_2SO_{4(c_1)}$, $M_2SO_{4(c)}/Hg_2SO_4/Hg$. The activity coefficients of potassium and sodium hydroxides in their corresponding sulphate solutions are calculated from measurements of cells of the type: $H_2/M_2SO_{4(c)}$, $MOH_{(c_1)}/M_xHg/MOH_{(c_1)}/H_2$. The ion activity-coefficient of water in the salt solutions as computed from the results of these cells is found to be greater in potassium than in sodium sulphate solution at a given concentration, a fact in agreement with the behaviour of potassium and sodium chloride solutions. From these results it appears that the value of $\sqrt{c_H . c_{OH}}$ is rapidly increased by the first addition of the sulphates, and that sodium sulphate causes a somewhat greater increase in this quantity than potassium sulphate. In the sodium sulphate solutions $\sqrt{c_H . c_{OH}}$ reaches a maximum at 1·5 m. and then decreases somewhat with increasing salt concentration. [See also Abstract 2406 (1925).] J. N. P.

**2232.** *The Influence of the Solvent on the E.M.F.* **A. E. Brodsky.** (Zeits. phys. Chem. **121.** pp. 1–25, May 24, 1926.)—E.M.F. determinations are made at different temperatures and with an accuracy of 0·0002 to 0·0003 volt of the cell $Hg/Hg_2Cl_2 . KCl/KBr . Hg_2Br_2/Hg$ in water, methyl alcohol, and mixtures of methyl and ethyl alcohol with water. The change of e.m.f. with temperature is linear, and the coefficients only vary slightly in different solvents. A marked effect is exerted on the e.m.f. by the nature of the solvent, which is related to its influence on the electrolytic solution tension. Its influence on the e.m.f. agrees with the results derived from thermodynamical deductions. In accordance with theory, the e.m.f. values in saturated solutions are found to be independent of the solvent. The calculated heats of reaction are markedly affected by it, and with water are in close agreement with thermal measurements. The influence of the solvent is thus related to changes in solubility and to the degree of dissociation to an extent which can be determined thermodynamically. *The Influence of the Solvent on the Electrode Potential.* (*Ibid.*, pp. 26–38, May 24, 1926.)—Electrode potentials of $Hg_2/HCl_2$, KCl- and of $Hg/Hg_2Br_2$, KBr-electrodes against N/10 calomel electrodes are measured in water, ethyl- and methyl-alcohol water mixtures at different concentrations of potassium chloride and potassium bromide. The electrode potentials agree with the values calculated on thermodynamical grounds from the solubility, and in saturated solutions the potentials are independent of the solvent. A linear relation is found between the potentials and the reciprocals of the dielectric constants of the solvents, and the relation is discussed from a theoretical standpoint. [See also Abstract 1846 (1913).] J. N. P.

**2233.** *The Thermodynamical Potential Differences at the Boundary of Liquid Phases.* **S. Wosnessensky, K. Astachow** and **K. Tschmutow.** (Zeits. phys. Chem. 121. pp. 143–152, May 24, 1926.)—Cells with only one p.d. at the phase-boundaries of two immiscible liquids can be set up owing to the fact that, in certain cases, liquids miscible with water in all proportions will not mix with aqueous solutions of certain electrolytes. Measurements of the e.m.f. of such cells, with methyl and ethyl alcohols and acetone as the liquids and potassium chloride, potassium carbonate and ammonium sulphate as electrolytes, show exceptionally high values of e.m.f. for KCl and acetone. The e.m.f. varies with the time for cells using amyl alcohol and KCl or KOH. B. W. C.

**2234.** *Manganese Dioxide-Permanganate Electrode.* **D. J. Brown** and **R. F. Tefft.** (Am. Chem. Soc., J. 48. pp. 1128–1132, May, 1926.)—The electrode potential of the manganese dioxide-permanganate electrode in a solution of perchloric acid was determined. The value of 1·586 volts was obtained for the oxidation potential of the reaction $MnO_4^- + 4H^+ + 3F^- = MnO_2 + 2H_2O$ in perchloric acid solutions. Changes in the concentration of the acid caused a variation in the electrode potential, which agreed with the calculated value. F. J. B.

**2235.** *Ionic Activity versus Concentration.* **G. McP. Smith.** (J. Phys. Chem. 30. pp. 849–857, June, 1926.)—The recent investigations of the author on the behaviour of strong electrolytes have been discussed by Bjerrum and Ebert, and they point out that the equilibrium data can be interpreted by the use of ionic activities instead of concentrations. The views of Bjerrum and Ebert are critically reviewed. The equilibria between amalgams and aqueous solutions of sodium and potassium halide mixtures are considered in the light of the use of ionic activities, as Bjerrum and Ebert indicated. F. J. B.

**2236.** *Electrochemical Behaviour of Chromium.* **E. Liebreich** and **W. Wiederholt.** (Zeits. Elektrochem. 32. pp. 261–263, May, 1926.)—The authors criticise the conclusions of Grube, Heidinger and Schlecht on the passivity of chromium [Abstracts 1724 and 1725 (1926)]. To this criticism **G. Grube** replied in a polemical manner, which again was replied to by Liebreich and Wiederholt. F. J. B.